PROFOUND AND MULTIPLE LEARNING DISABILITIES AND LANGUAGE: AN INVESTIGATION INTO THE USE OF MEANINGFUL, INTELLIGIBLE SUB-VOCAL UTTERANCES BY CHILDREN AND YOUNG ADULTS WITH PROFOUND AND MULTIPLE LEARNING DISABILITIES.

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ABSTRACT

Aims

The aim of this thesis is to investigate the use of sub vocal (SV) meaningful utterances by 20 children and young adults assessed by their teachers as having profound and multiple learning difficulties (PMLD.) People designated PMLD are believed to be incapable of using language beyond a few words or symbols and to operate developmentally between 0-24 months, prior to the acquisition of language. Nevertheless, digital recordings captured linguistic sub vocal utterances, apparently meaningful and intelligible by 20 research participants. Consequently, the research hypothesis proposed that:

Children and young adults designated PMLD can produce meaningful sub vocal utterances intelligible to listeners.

Background

This research is situated within special educational provision in England, including schools and colleges meeting the needs of children and young adults designated as having profound and multiple learning disabilities (PMLD). Currently, they are believed to be characterised by profound developmental delay such that they operate at developmental stages associated with infancy (0-24 months.) Integral to this is the understanding that they are pre-linguistic and pre-verbal. In contrast, this study explores the use of sub vocal utterances demonstrating language acquisition and developmental stages above infancy for the 20 research participants.

Method

The research is comprised of four separate phases, each phase investigating a different element of the production of meaningful SV utterances by the participants The participants were selected on the basis of the medical and educational designation of their profound and multiple learning disabilities. The same 20 children and young adults participated in all four phases of the study.

Phase 1 investigated the research question:

How do the SV utterances compare acoustically and phonetically with normative samples where instrumental analysis allows comparison of the acoustic phonetic features?

Phase 1 employed Praat sound software to carry out instrumental analysis of the phonetic and acoustic characteristics of participant SV utterances in comparison with normal speech and whisper. This was to establish that the utterances were more than 'noise' and contained acoustic phonetic 'speech like' features

Phase 2 investigated the research question:

Are the SV utterances intelligible such that familiar and naïve listeners would be able to understand the amplified samples?

Phase 2 gathered quantitative data on the ability of 40 listeners to perceive the

participant SV utterances as intelligible. Phase 2 used 10 tests (7 closed and 3 open) of intelligibility to provide evidence of the ability of 20 naïve and 20 familiar listeners to perceive SV utterances as intelligible.

Phase 3 investigated the research question**:**

How sophisticated is the language used in utterances? Does it demonstrate linguistic and cognitive levels beyond the developmental age of 0-24 months
attributed to individuals designated PMLD?

Phase 3 used three language assessment measures to identify if the content and structure of participant utterances exceeded the developmental and linguistic levels of infancy (0-24 months) attributed to individuals designated PMLD. Phase 3 used National Curriculum Performance Levels, Mean Length of Utterance and Developmental Milestones to measure the content and structure of participant SV utterances to show that the 20 research participants were operating above the pre-linguistic and developmental levels currently associated with PMLD individuals.

Phase 4 investigated the research question:

Are the SV utterances produced by the research participants meaningful?

Phase 4 explored the ability of participants to produce meaningful SV utterances. A series of semi structured interviews between the researcher and the 20 participants demonstrated their ability to produce utterances which are meaningful defined as:

- ‘significant, important, relevant, valid, purposeful. (Oxford Dictionary, 2008)
- contextually appropriate
- using abstract concepts including views, opinions and ideas

Findings

Phase 1

Data from the analysis of SV utterances demonstrated the presence of speech sounds and identified acoustic phonetic features in SV utterances comparable to those in normal speech and whisper.

Phase 2

The findings of Phase 2 established the intelligibility of SV utterances in 10 tests of intelligibility as assessed by 20 naïve listeners and 20 familiar listeners.

Phase 3

Phase 3 provided evidence of linguistic and developmental levels of the content and structure of SV utterances beyond 0-24 months that exceeded those attributed to individuals designated PMLD as pre-linguistic and profoundly developmentally delayed.

Phase 4

In Phase 4 participant responses in semi structured interviews showed the ability of participants to produce meaningful language as SV utterances, including abstract concepts demonstrated as views, opinions, and ideas.

Conclusions

The conclusions from the 4 phases of the research were as follows:

1. As proposed by the hypothesis, 20 research participants designated PMLD can produce meaningful sub vocal utterances intelligible to listeners.
2. Acoustic phonetic features integral to normal speech and whisper can be identified in SV utterances including the presence of a ‘speech like’ event.
3. SV utterances by the participants were intelligible to 40 listeners in closed and open conditions.
4. The content of SV utterances encompass developmental and linguistic levels beyond the developmental age of 0-24 months attributed to individuals designated PMLD.
5. The 20 research participants can produce meaningful language as SV utterances including abstract concepts expressed as views, opinions, and ideas

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DEDICATED TO

The 20 children and young adults who participated in this research. Their contribution has been immense.

DECLARATION

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. This thesis was completed in collaboration with the School of Life and Health Sciences at De Montfort University.

Name: ROSEMARY WOODS

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Date :September, 2020

CHAPTER 1: INTRODUCTION TO THE THESIS

This thesis records a research study over a period of seven years into the use of sub vocal (SV) phonation to produce meaningful utterances by children and young adults designated as having Profound and Multiple Learning Disabilities (PMLD.)

Throughout this thesis, samples of amplified sub vocal utterances by participants are used in conjunction with transcriptions to demonstrate and illustrate the relevant aspects of utterances under examination. The quality of the utterances are variable, within and between participants, producing some clear and precise articulatory patterns while others are less so. For listeners who are not familiar with disordered speech, samples may need to be replayed more than once. The range of samples contribute to the weight of evidence that children and young people designated PMLD can produce SV meaningful utterances intelligible to listeners. They have acquired and use language.

This chapter is divided into two sections.

Section 1 presents an account of the research process. It explains the rationale for the research and how the research aims were identified.

Section 2 presents details of the structure and organization of the investigation

Section 1: The research process

As a Head Teacher of three different special schools, the researcher gained wide experience with a range of pupils with learning disabilities. The research topic was initially identified as a result of work with pupils designated PMLD, during which disordered, dysarthric type vocalisations were digitally recorded for examination of the speech sounds. The apparently random and meaningless recorded vocalisations of one individual (Participant 1) were examined.

Sections of the recordings between vocalisations by Participant 1 were inadvertently amplified and revealed sub vocal phonation, initially nominated ‘whispers,’ which appeared to include phrases using words and sentences. The presence of meaningful language was apparent. Although not perfectly articulated, phases produced in this way appeared to be much clearer in comparison with the audible, distorted vocalisations commonly made by Participant 1.

Family members understood the ‘whispers’ (later identified as sub vocal phonation) as meaningful, in comparison to the audible yet disordered vocalisations frequently produced by Participant 1. This suggested the possibility that other individuals designated PMLD might also produce such utterances and exploration of this possibility was central to the project. This phenomenon appeared to run contrary to existing understanding of the linguistic abilities and developmental levels of the PMLD population, assumed to operate developmentally between 0-24 months, as do infants. Thus, individuals designated PMLD are both pre-verbal and pre-linguistic, lacking the linguistic and developmental levels that facilitate the acquisition and use of language. Consequently, this research was designed to investigate if 20 research participants designated PMLD could produce meaningful SV utterances, intelligible to listeners. If

they could be shown to do so, findings would provide evidence of linguistic and developmental abilities currently believed to be lacking in the research participants and others in this population. The SV utterances of 20 participants were recorded. It was apparent that they could all use SV language in this way. Participant 2 demonstrates, responding to hearing his recorded and amplified SV utterances for the first time.

Chapter 1 a sample

Participant 2: My voice, speaking with sound.

That's myself.

My dream.

Talking with Dad.

Participant 7 also recognizes that it is her voice that she hears

Chapter 1 b sample

Participant 7: You will hear me talk

1.1 identifying the research process

The existence and description of sub vocal phonation in individuals designated PMLD presented as a general research topic. An entirely innovative technique enabled SV phonation (inaudible to the human ear) by 20 research participants to be digitally recorded and amplified. The recordings provided an extensive data set of the SV

utterances and enabled the outline of the research topic to be identified. Recourse to the literature made clear the unique nature of this phenomenon so that an examination of SV utterances and their properties and characteristics was planned. It was apparent that the existence, structure and content of SV utterances by participants designated PMLD were absent from the literature. . Against this background, relevant aspects of the study were identified, leading to a more narrow emphasis on a number of questions to identify and define the research focus:

1. How do the SV utterances compare phonetically with normative samples where instrumental analysis allows comparison of the acoustic phonetic features?

2. Are the SV utterances intelligible such that familiar and naïve listeners would be able to understand the amplified samples?

3. How sophisticated is the language used in utterances? Does it demonstrate linguistic and cognitive levels beyond the developmental age of 0-24 months commonly attributed to individuals designated PMLD?

4. Are the SV utterances produced by the 20 research participants meaningful?

The research was designed in order to answer the above questions by exploring four aspects of the SV utterances.

Phase 1 addressed Question 1, and was designed to conduct an acoustic/phonetic analysis to determine the relationship of SV utterances to normal speech and

whispers. This could provide data on the features and characteristics of participant SV utterances and the extent to which they could be recognised as 'speech like.'

Phase 2 addressed Question 2 and was designed to test the intelligibility of SV utterances by assessing the ability of 40 listeners to correctly perceive the content.

Phase 3 addressed Question 3 and was designed to identify the developmental and linguistic levels of the content of utterances to identify competencies in the research participants above those attributed to infants (0-24 months).

Phase 4 addressed Question 4 and was designed to explore the 'meaningful' nature of SV utterances.

The above questions reflected the unspecified nature of the phenomenon, identifying the absence of information about SV utterances and the lack of awareness by education staff, parents and carers about the language demonstrated in the participants' recorded SV utterances. A research study provided the means to explore the presence and use of SV utterances by 20 children and young adults designated PMLD, particularly as their inability to demonstrate their linguistic and developmental competencies in other ways had contributed to the assessment of their profound developmental delay.

1.2. Background

An examination of the present assumptions about people designated PMLD and their abilities provides the background to the first part of this research. It explores

understandings of the features and abilities currently acknowledged as characteristic of people designated PMLD

Individuals designated PMLD are considered to be profoundly developmental delayed, operating at stages associated with infancy (Burford, 1988; Carnaby, 2004; Coupe O'Kane & Goldbart, 1998; Nind & Hewett, 1994; Samuel & Pritchard, 2001). Integral to this designation is their inability to use language. They are pre-linguistic, pre-verbal, using forms of communication before words (Goldbart and Caton 2010) pre-symbolic and pre-intentional (Coupe O'Kane & Goldbart, 1998; Goldbart, 1994); Nevertheless, the researcher recorded samples of 'speech like' SV utterances by an individual designated PMLD, apparently meaningful, intelligible, and developmentally and linguistically in advance of the PMLD characteristics attributed to the research participants. Such recordings signified language abilities contrary to those ascribed to PMLD people by authorities, researchers and professionals in the field. In education too, assumptions about the pre-linguistic nature of PMLD pupils and students guided the researcher's teaching and curriculum provision, potentially inappropriate if individuals were linguistic and developmentally beyond infancy.

1.3. Classification

The classification of the participants and the population referred to in this thesis requires a shared understanding of the diagnoses, characteristics and needs of the people to whom the research refers. The potential complexities and confusion arising where different terminologies or classifications are adopted in different settings and by different agencies may result in disparate understandings of the term 'PMLD' used in this research. Consequently, in order to ensure the consistent recognition of the

participants and an appreciation of the intellectual abilities attributed to them, the categorisation of ‘profound and multiple disabilities’ requires a recognised classification when used in relation to individuals designated PMLD who are referenced in this study.

Apter (2019) identifies two widely established systems used for the classification of developmental disorders and both were considered initially. The first, centred on North America, is The Diagnostic and Statistical Manual of Mental Disorders (DMS.) and is published by and generates income for the American Psychiatric Association. It is largely concerned with psychiatric conditions. The second, The International Classification of Disease (ICD) has been utilized since 1948 by the World Health Organisation (WHO) a global agency that is multidisciplinary and multilingual with 194 member states. Access to ICD is free on the internet. ICD has provided the means for member nations to classify, report on and monitor diseases and conditions to facilitate the consistent collection and comparison of data between nations and across time. In comparing the two systems, the multilingual and multinational nature of the ICD identified greater strengths in comparison with DMS. However, in determining the most appropriate classification to employ for this research, further consideration was given to how the different agencies report the classification for ‘profound’ disabilities.

At the start of this research the ICD and the DMS used different classifications for ‘profound’ disabilities. The then current ICD-10 provided an international classification for reporting diseases and health conditions defined as ‘intellectual learning disability’ as seen in the Table 1 below, categorising individuals with ‘profound’ intellectual disabilities as those with an IQ below 20, that is with the lowest IQ.

Table 1.1 The WHO categories of intellectual disability based on IQ levels

Borderline	70-9
Mild	50-69
Moderate	35-49
Severe	20-34
Profound	> 20

More recently, ICD-10 has been revised to reflect advances in health and medical science over time. ICD-11 was released in 2018 to enable Member States to prepare for implementation of this revision. It is intended to come into effect in 2022. Comparison of the revised version ICD-11 with DMS was undertaken, contributing to the decision to use ICD for the preferred classification of PMLD. Girimaji and Pradeep show the comparisons between International Classification of Diseases-11 and Diagnostic and Statistical Manual of Mental Disorders-5 Approaches to Intellectual Disability. (Girimaji and Pradeep,2018). See Appendix 1

The DSM-5 categorises profound intellectual disabilities based on adaptive skill attainment alone as determined by standardised testing and clinical assessment. It is concerned largely with psychiatric diseases, while ICD-11 encompasses all health disorders so has particular relevance for medical professionals. This may also be important for PMLD individuals in this research where comorbid classification may

apply to such joint conditions as PMLD and Cerebral Palsy.

An additional advantage in using ICD-11 classification includes reference to severity of impairments by ICD-11, denoted in Table I (Appendix I) emphasising the degree of difference between intellectual disabilities and marking more clearly the differences between categories of mild, moderate, severe and profound intellectual disabilities. ICD-11 also places more emphasis on clinical behaviour indicators when standardized tests of intellectual function and adaptive functioning cannot be administered (and is particularly applicable to the research participants in this research). In addition, the greater detail and defining features included in ICD-11, yet absent in DMS, present a range of behavioural indicators in conceptual, practical and social skills seen as applicable to PMLD individuals. ICD-11 classifies profound intellectual disabilities on severity of impairments in intellectual functioning and on adaptive behaviour measured by standardised tests or clinical indication where tests are not viable. ICD-11 refers to intellectual disabilities using the term 'Disorders of Intellectual Development (DID) as

" a group of etiologically diverse conditions originating during the developmental period characterized by significantly below average intellectual functioning and adaptive behaviour that are approximately two or more standard deviations (SDs) below the mean (approximately <2.3rd percentile), based on appropriately normed, individually administered standardized tests. Where appropriately normed and standardized tests are not available, diagnosis of DID requires greater reliance on clinical judgment based on appropriate assessment of comparable behavioural indicators.'

The government in England have yet to make a decision regarding implementation of ICD-11 for services in England, including the NHS (National Health Service). WHO

anticipates that Member States, of which the UK is one, will instigate ICD-11 according to their own requirements, resources and guidelines, during which time WHO will accept recorded data for both ICD-10 and ICD-11, facilitating the classification of the research participants within both ICD categories currently, yet with the recognition of classification by ICD-11 in the future if implemented by Member States.

At a more practical level, the British Psychological Society (2015) note that definitions of intellectual disability (previously known as learning disability) both nationally and internationally refer to three key criteria to included:

- a significant impairment of intellectual functioning
- a significant impairment of adaptive behaviour (social functioning)
- both impairments arising before adulthood

These criteria are embodied in the mental capacity legislation in the UK and in the classification systems reported above (DSM and ICD).

In Education provision in England where this research is based, the designation of PMLD is aligned with assessment on Performance Scales (P Scales or P Levels) required by the Government (1998) in association with National Curriculum Guidelines for Special Schools.(1988). Attainment at P Levels 1-4 designate pupils as PMLD . All research participants in this study meet assessment criteria at levels between P1-P4, (further discussed in Phase 3 of this research).

1.4. PMLD terminology used in England.

In addition to consideration of the appropriate classification for PMLD individuals there are similar issues regarding PMLD terminology used by a range of organisations, agencies and services meeting their needs in the England.. Variations in terminology are evident in research literature and in descriptive accounts of PMLD individuals for whom provision is made by health, psychological, educational, and social agencies.

Gittens and Rose (2007) identify the lack of an agreed definition for PMLD and sub-sequent problems in identifying PMLD clients and their needs. Belamy et al (2010) acknowledge the lack of a universally agreed definition of the term PMLD, recognising that variations in terminology for this population are matched by descriptive variations of the characteristics that define this group. Although the term PMLD is used throughout this study, literature referring to this population encompasses a range of terms, all of which incorporate profound intellectual delay in association with a wide variety of medical, neurological, sensory and physical impairments. The term 'PMLD' used for people with Profound and Multiple Learning Disabilities, is seldom specific. Nevertheless, there is a need for a shared terminology to encompass participants in this study, to incorporate an understanding of the characteristics attributed to those individuals described as PMLD as recommended by Mansell (2010) who specified the need for clarity to establish those defined as profoundly developmentally delayed.

Despite the recognised need for consistency in terminology, Social Constructionists such as McClimens (2005) have criticised the use of labels to categorise disability, as a means to ascribe lesser value, particularly by service providers. In recognition of the validity of this criticism, terminology used here does not reflect a lesser regard for those people defined by PMLD descriptors, but as a means to recognise the complex needs

of the research participants, and of the wider population from which they are drawn. Clarity about who is and who is not categorised as PMLD is essential in identifying those people who are the focus of this research. A definition of terms facilitates consideration of how they are currently represented in the literature and ensures too, as much as possible, the uniformity of the population encompassing the research participants.

Nakken and Vlaskamp (2002) identified 13 different descriptors used in research studies in this area, compounding difficulties both in identifying those to be included or excluded and potentially limiting access to participants for research studies. Subsequently, a range of terms has been employed by researchers. Nakken and Vlaskamp (2002) and Emerson (2009) use 'profound multiple learning disabilities,' while Ware (2004) refers to this population as having 'profound and multiple learning disabilities.' Jones (2005) describes the term 'profound and multiple learning difficulties' as generally used by teachers of this population. Mansell (2010) Hostyn and Maes (2009) and Pawlyn and Carnaby, (2009) use 'profound intellectual and multiple disabilities' (PIMD.) Thus, different researchers, professionals and agencies in England use different terminology with reference to PMLD individuals, compounding and obscuring mutual understanding rather than clarifying terminology.

For educational issues, Gates and Mafuba (2016) propose that variations in UK terminology need clarity to facilitate common understanding within the wider, international community. Gates and Mufuba distinguish between 'learning disabilities' as applicable to global developmental delay leading to failure to achieve normal milestones , and 'learning difficulties' associated with learning disorders that inhibit

different types of information processing. The Department of Education (2010) however refer to PMLD individuals as pupils with profound and multiple learning 'difficulties' while the National Health Service defines PMLD individuals as having a severe learning 'disability' (NHS Data Model and Dictionary) but also use 'intellectual disability' as used by the Department of Health in a report by Mansell (2010) Raising Our Sights: services for adults with profound intellectual and multiple disabilities.

Due to the variations in terminology and the resulting complexities, and in order to ensure clarity as suggested by Gates and Mafuba (2016) the terminology to be used in this research is defined. While acknowledging that a wide variety of terms are still in common usage by researchers and professionals referenced in this paper, the term 'Profound and Multiple Learning Disabilities (PMLD) is adopted, considered by the researcher to encompass the concept of the profound nature of the developmental delay in association with the multiple physical and sensory impairments that typify participants in this educationally based research. In addition, this term is in current use in Special Education in England , used in conjunction with assessments employed by the teachers of the research participants

1.5. Intellectual impairment

The description of individuals designated PMLD reported above encompasses a range of disabilities, impairments and conditions that indicate a level of functioning prior to language acquisition and development. The potential presence of sub vocal phonation to produce meaningful utterances by PMLD individuals runs counter to existing understanding of their developmental levels in language, cognition and communication, where the profound nature of their developmental delay contradicts

expectations of competencies beyond infancy.

A degree of profound intellectual impairment as characteristic of people designated PMLD has been acknowledged by a range of researchers and authorities. Mansell (2010) refers to extremely delayed intellectual and social functioning, reflecting a view previously put forward by Carnaby (2002.) Hogg (2004) Samuel and Pritchard (2001) and Ware (2004).) The Welsh Assembly Government (2006) refer to profound cognitive impairment/learning difficulty, leading to significant delay in reaching developmental milestones. Such learners will be operating overall at a very early developmental level. Simmons and Bayliss (2008) acknowledge that individuals designated PMLD are frequently compared to pre-verbal infants characterised by forms of non-verbal communication associated with an extremely young developmental age.

With specific reference to developmental levels, agreement among researchers and authorities places PMLD people within a developmental period of 0 – 24 months (Cunningham, 2016., Imray, 2005., Ware, 1996). Lacey, (2011) acknowledges that the PMLD curriculum in many special schools reflects an early developmental perspective, often in association with Routes for Learning (2006) an assessment and curriculum approach reflecting developmental stages comparable to those of the neonate or infant. The implications of this for language and cognition are an important consideration for this research, identifying as it does the presumption of limited developmental and linguistic competence in people designated PMLD.

1.6. Language development in people designated PMLD

In association with the profound cognitive and intellectual impairment attributed to PMLD individuals, there is an associated expectation of severely limited language and communication. (Bellamy et al 2010., Imray, 2005., Mansell 2010 ., Nind and Hewitt, 2005., PMLD Network, 2016., Routes for Learning, 2006.) Samuel and Pritchard (2001) refer to little or no apparent understanding of verbal language, while Mansell (2010) and Hogg (2004) consider that for individuals designated PMLD, there will be great difficulties in communicating, being typically non-verbal, at most using a few words or symbols. They are deemed to be pre-linguistic due to the developmental delay that places them within the period of infancy, prior to language acquisition.

1.7. Incidence

Williams (2008) emphasises the need to clarify the number of people categorised as PMLD and to specify their needs in order to facilitate rational planning and service provision. Emmerson and Hatton (2008) refer to the difficulties in producing accurate figures for people with learning disabilities in England, where data is not collected nationally. Consequently, official figures are estimated rather than reliable. The ‘People with Learning Disabilities in England’ (2013) a study by Public Health England estimated the incidence of PMLD children to be 10,525, with 8,736 attending special schools. Similarly, information from the Department for Education (DfE, 2016) identified 180,000 children in England with Special Educational Needs, of which 1 in 20 had PMLD. Of 70,000 children with a Statement of Special Educational Needs, 8,750 had PMLD. (Public Health England 2016.) By 2018, 11,014 children were identified by Public Health, England as PMLD in primary of secondary educational provision, an increase of 16% from 2010 and identified as less than 1% of the children with SEN (Special Educational Needs).

The incidence of PMLD adults in England has been estimated by Emmerson (2009) as 16,000 adults to increase by 1.8% annually to 22,000 in 2026. Thus, in a population of 250,000 people per average area, incidence will increase from 78 in 2009 to 105 in 2026, with a higher incidence in areas representing a younger demographic (Emerson 2009.) Significantly, the Department of Health (2001) has predicted increased survival rates for numbers of children and young people with complex and multiple disabilities due in part to intensive neonatal care. Thus, the population of children and young adults with profound and multiple learning disabilities will increase. (Mansell, 2010)

1.8. The importance of the research

The research study constitutes a timely and relevant issue for research because of the limited expectations of the linguistic and developmental abilities of individuals designated PMLD, including the research participants. Researchers and academics in this field propose that PMLD individuals are by definition, pre-linguistic, pre-verbal, pre-intentional and pre-symbolic symbolic (Barber, 1998., Grove et al,1999., Imray, 2005., Samuel and Pritchard, 2001., Vlaskamp et al, 2007.) They can neither use nor understand words or symbols. In contrast, evidence of the meaningful use of SV utterances may contradict this universal view and contribute towards an examination of the legitimacy of this opinion in respect of the PMLD participants in this study. Demonstration of sub vocal linguistic competence may have implications for the range and type of opportunities and interventions made available to them and possibly to others who can produce SV utterances. The contribution of this study includes the following:

1.9. Motor speech development

Currently, the existence and use of sub vocal phonation to produce meaningful

utterances by PMLD individuals appears to be absent from research on motor speech development for both normal and disabled speakers. An investigation into the characteristics of this form of phonation may contribute to this area of research offering both practical and theoretical considerations of sub vocal phonation as a new variable in communication disorders and a new approach in communication interventions for PMLD individuals.

1.10. Communication interventions

The failure by individuals designated PMLD to demonstrate their acquisition of language often results in the use of communication interventions that are pre-linguistic. However, recognition of the ability of individuals to use and understand language in the form of SV utterances may offer access to a range of communication approaches currently unavailable to them. The opportunity to facilitate communication in ways that meet and capitalise on their use of SV meaningful language can be offered if the presence of SV utterances can be demonstrated.

1.11. Clinical approaches

For the 20 research participants, the initial designation of PMLD is medically derived in association with named syndromes (where they can be identified) and complex health needs identified during infancy (Rees, 2017.)

‘The power to diagnose and treat children with disabilities is located within the medical professions…. parents of children with severe and profound difficulties are reliant on information from medics both to understand specific developmental characteristics and to address their child’s health needs.’ Rees (2017, p.32)

Educationally, an assessment of intellectual functioning in an individual designated PMLD must be undertaken by a qualified applied psychologist (BPS,2001). Once attributed, the presumption of PMLD can be maintained if there is a failure by individuals with physical and sensory impairments to respond to assessment strategies intended to evaluate their competence. However, if the existence of language as SV utterances can be identified, potentially indicating and identifying abilities and competencies currently obscured, reconsideration of the original designation of PMLD may be considered, especially where assessment against P Level assessment criteria demonstrates competences above P1-4 in association with National Curriculum Guidelines for Special Schools.(1988).

1.12. Self advocacy

The severe restrictions on communicative efforts by people designated PMLD effectively limit efforts to seek out or realistically represent their views (Ware 2004.) In contrast, evidence for the existence and use of sub vocal phonation offers PMLD individuals a means to express their own needs, wants and interests in order to contribute to, or influence, services and provisions made for them. Additionally, the recognition of their linguistic competence has implications for the recognition of their intellectual competence and the validity of their opinions, views and ideas where these can be expressed using SV utterances at appropriate developmental and linguistic levels

1.13.Technology

Currently, the inability of PMLD people to demonstrate sufficient cognitive and linguistic understanding beyond that of an infant can lead to a failure to explore their potential to access a range of IT devices as alternative or augmentative aids to speech. Recognition of a greater degree of linguistic and developmental ability than has been

previously realised may facilitate the use of devices formerly considered to be beyond their capacity. Acknowledgement of their SV phonation may offer new options, including the use of (SV) voice activated devices.

1.14.Social attributes

The social awareness and social competence demonstrated by the participants in their sub vocal utterances may improve the quality and quantity of their social engagements with those around them. Evidence of their ability to converse meaningfully has important implications for how they are both viewed and treated within a social context.

SECTION 2

1.15. The organisation and structure of the research

Section 2 details the structure and organisation of the research. The outline of each chapter is summarised as follows:

Chapter 1: Introduction

Chapter 1 introduces the research, explaining the rationale underpinning the research focus and detailing the structure and organisation of the study.

Chapter 2: Literature Review

This chapter explains how the literature review was conducted, enabling the researcher to draw upon existing academic research pertinent to the concepts underpinning this study, and to identify appropriate methodologies and data collection techniques to be used to explore the hypothesis. The outcomes of the literature review

has contributed to the methods for the investigation and analysis of sub vocal phonation. It identified the means to determine the phonetic and acoustic features of SV utterances. While this is an under researched area in respect of people designated PMLD, research in phonation, both normative and disabled is extensive, providing an academic basis to the study and a means to focus on relevant ideas and concepts.

With specific reference to people designated PMLD, the literature review examined previous research that provided insight into current assumptions about the linguistic and cognitive abilities of this population. An exploration of the communication interventions offered to individuals designated PMLD was undertaken, considering current understanding of the communication competence of this population in relation to the interventions made available to them and the failure to identify the linguistic competence demonstrated in SV utterances Particular attention was paid to the development of language and communication and the associated pre-requisites.

The review also explored issues of intelligibility and those features of normative and disordered speech that are considered to influence listener perception. The review informed decisions about the means of constructing tests of intelligibility, an important aspect of the research and also provided a framework for the exploration and assessment of the linguistic and developmental elements of the content of SV utterances. It guided the selection of the techniques required for facilitating participant contributions to the research where the meaningful nature of their SV utterances was appraised.

Chapter 3: Methodology

Chapter 3 presents the philosophical tenets underpinning the research methodology and details the research approaches employed in this study. It acknowledges the apparent lack of research specific to sub vocal phonation by people designated PMLD and identifies other relevant areas of research to be examined to compensate for this lack. Decisions effecting the selection of research approaches are considered. It relates the research paradigm to the research strategy and advocates a mixed method design, using both quantitative and qualitative research approaches. It describes and examines the methods employed for implementing a mixed method approach for gathering qualitative and quantitative data for analysis. It considers the advantages and the limitations of doing so. It discusses the choice of quantitative and qualitative measures and statistics in relation to the hypothesis and the collection, organisation and analysis of data. It acknowledges the multifaceted nature of a research project that requires the exploration of different elements of the same phenomenon, in ways that facilitate investigation and integration of different components at different stages, both concurrently and consecutively.

Chapter 4: Methods

Chapter 4 presents the methods used in the research. It describes the organisation of the research as four interlinked phases, each examining different aspects of the phenomenon of SV phonation yet maintaining the underlying cohesion that provides the overall framework. It details the design and implementation of each phase and the tools used for the appropriate collection and management of data. It describes the instruments used and the associated procedures in digital recording of SV utterances. It presents the participants and their characteristics in relation to the inclusion and exclusion criteria for the research. Ethical considerations are discussed.

Chapter 5: Phase 1 : Acoustic analysis of utterances

Chapter 5 presents Phase 1 as the first of the four phases to examine the SV utterances produced by the participants. The focus of Phase 1 is on the identification and implementation of a procedure for the instrumental analysis of SV utterances, in order to compare the features and characteristics of utterances with normative samples.

Chapter 6: Phase 2: Intelligibility of utterances

Chapter 6 reports Phase 2. Phase 2 is concerned with listener intelligibility of SV utterances in order to substantiate the hypothesis that SV utterances are intelligible to listeners. This study details the planning, implementation and results of a series of closed and open listener tests of intelligibility.

Chapter 7: Phase 3: The content of utterances

Chapter 7 reports Phase 3. This examines the content of SV utterances and identifies assessment measures to examine linguistic and developmental levels made apparent by the structure and content of SV utterances. Current understanding proposes the acquisition of necessary concepts and developmental levels prior to language acquisition, necessitating evidence that participants have acquired such levels and concepts in order for their SV language to operate in excess of the pre-linguistic stages attributed to them.

Chapter 8: Phase 4: Meaningful utterances

Chapter 8 reports Phase 4 as a series of semi structured interviews conducted by the researcher with participants to facilitate responses exhibiting the meaningful nature of their utterances. Interview outcomes demonstrate the ability of participants to produce utterances which are:

- meaningful as defined by the Oxford Dictionary (2008) as 'significant, important, relevant, valid, purposeful.
- contextually appropriate
- using abstract concepts including views, opinions and ideas

Chapter 9: Discussion and conclusion

Chapter 9 presents the key findings resulting from the study. The contribution to knowledge is detailed, referring specifically to the key findings of the studies. It describes the outcomes of the four studies in relation to the hypothesis. It reports on what has been shown by each phase, focusing on the data analysis specific to each. This chapter integrates the results of quantitative and qualitative data obtained by the four studies and findings are specified and explained. It places outcomes within the context of the literature to evaluate the extent to which the findings are compatible with presently identified theories and constructs. It discusses the practical implications of the research . The importance of procedures to disseminate findings are highlighted and suggestions for further research in this area are made. It presents the conclusion to the study

CHAPTER 2: THE LITERATURE REVIEW

2.1. Part 1: Background and context to the thesis

Abstract

Introduction

The literature review explored studies pertinent to the research hypothesis:

Children and young adults designated PMLD can produce meaningful, sub vocal utterances intelligible to listeners.

Objectives: To identify and review literature detailing research studies applicable to an investigation into the production of intelligible, meaningful SV utterances by children and young adults designated PMLD.

Method. To search electronic and printed sources of literature to identify, review, analyse and synthesise the findings of data from studies applicable to the hypothesis.

Background

The background to the literature review is located in the language and communication provision in special education in England for children and young adults designated PMLD. Current understanding of the competence of individuals designated PMLD attributes profound impairments with regard to communication such that they remain pre-linguistic communicators throughout their lives (Pepper, 2020). Digital recordings of SV utterances by 20 PMLD research participants showed linguistic competences contrasting with those specified above. A research study to investigate the use of meaningful, intelligible SV utterances by 20 research participants designated PMLD

offered the opportunity to examine the existence, features and nature of this phenomenon.

2.2. Organisation of the literature review

Snyder (2019) recognizes the essential need for a literature review, requiring the consideration of previous, relevant research for all research projects. Similarly, Parè and Kitsiou (2017) propose that literature reviews are an essential means for ascertaining what has been written on a particular research topic. A literature review was therefore undertaken to establish the relationship between this study and existing research in order to:

- Refine the research questions
- Identify and evaluate existing knowledge.
- Identify a gap in the current corpus
- Ensure outcomes of the research would be original knowledge
- Identify tools, methodologies and approaches suitable for the research.
- Identify areas for further research.

The literary review process was tracked and recorded using documentation by De Montfort University (Hudson, N., and Law, C.ASS.DTP) See Appendices 11-V11

2.3. Framing the research questions.

Paré and Kitsiou (2006) consider that the research questions are central to the purpose of the literature review, guiding the review process and identifying the information required. Reference to the research questions informs the selection of

relevant literature and guides the subsequent analysis of the extracted data. The research questions for this study derived from the hypothesis:

Children and young adults designated PMLD can produce meaningful sub vocal utterances intelligible to listeners

The different elements of the hypothesis were extracted to create the research questions and the subsequent literature review questions.

Research Question 1

How do the SV utterances compare acoustically and phonetically with normative samples where instrumental analysis allows comparison of the acoustic phonetic features?

The apparent use of words and phrases in the recorded participant SV utterances suggested acoustic and phonetic parallels with normal speech and whisper. If this were the case, SV utterances could be shown to be 'speech like' and not simply acoustic noise. A means to investigate this possibility was sought. This led to:

Literature Review Question 1.

Are there any studies which compare sub vocal utterances with normative samples where instrumental analysis allows comparison of the acoustic phonetic features of normal speech and whisper with sub vocal utterances by individuals designated PMLD?

Research Question 2

Are the SV utterances intelligible such that familiar and naïve listeners would be able to understand the amplified samples?

The researcher and adults familiar with the first 'speaker' were able to understand his SV utterances. Recorded utterances were variable however, and listener intelligibility was not a constant. This led to a consideration of the intelligibility of the words and phrases used in relation to listener perception. A means to assess the intelligibility of the SV utterances of the 20 research participants was therefore planned and led to:

Literature Review Question 2:

Are there any studies that explore listener intelligibility of sub vocal utterances of normal speakers or individuals designated PMLD?

Research Question 3

How sophisticated is the language used in utterances? Does it demonstrate linguistic and cognitive levels beyond the developmental age of 0-24 months attributed to individuals designated PMLD?

For Participant 1, familiar staff, family and carers were surprised by the content of the recorded utterances, indicating a level of developmental and linguistic competence at variance with the linguistic and developmental levels (0-24 months) attributed to

people designated PMLD. Consequently, a further question emerged as

Literature Review Question 3:

Are there any studies which examine the functioning of PMLD individuals beyond the linguistic and developmental levels associated with 0-24 months?

Research Question 4

Are the SV utterances produced by the research participants meaningful?

Evidence of SV utterances obtained in the earliest stages of the research indicated that utterances produced by the research participants were not only intelligible but also meaningful. Therefore, the literature review looked for studies that focused an examination of the meaningful nature of language used by individuals designated PMLD, using the definition of meaningful as:

- 'significant, important, relevant, valid, purposeful. (Oxford Dictionary, 2008)
- contextually appropriate
- using abstract concepts including views, opinions and ideas

Literature review Question 4

Are there any studies that examine the meaningful nature of words or phrases by individuals designated PMLD?

2.4. Scoping review

Once the review questions were identified, an initial broad, scoping review of the literature was undertaken to seek evidence of studies relevant to the research questions. This was a necessary first step to confirm the presence of sufficient literature to ensure that the research could be both feasible and sufficiently detailed, during which gaps in the literature might also be identified. For the initial broad scoping review therefore, Google Scholar was searched (with no time limit) selected for the wide extent and breath across a variety of disciplines and sources, potentially offering further links via references and citations to additional information. This is also a free data base, postponing additional costs likely to be necessary in subsequent searches. Other data bases were scanned , establishing the presence of sufficient relevant literature applicable to acoustic analysis, intelligibility, linguistic and developmental levels and meaningful communication for people with profound learning disabilities. Initially, it was not considered essential to include PMLD in all search terms as literature pertaining to other learning disabilities or normal functioning might also be applicable to the research but PMLD was included in due course to ascertain the presence or otherwise of literature specific to this population and the research participants within it.

2.5. Outcomes of the scoping review

The initial broad scoping review identified an absence of studies where participants used SV utterances specific to the research questions but a range of associated studies offered applicable and relevant information, providing a background and

framework on which the study could draw, particularly, with regard to methods, tools and study designs. Thus, the scoping review revealed sufficient available literature to ensure that relevant and appropriate data would be accessible to ensure the feasibility of the research. The limitations in literature specific to PMLD sub vocal utterances also suggested a gap in the corpus, to be further explored during the narrative review.

Results of the initial scoping review were recorded in a table. See sample, Appendix II.

Brief notes were taken, referring to the idiosyncrasies of different data bases, mainly accessed through the De Montfort University learning services A-Z of databases. See sample Appendix 111

During the scoping review, articles of particular interest was recorded for further investigation. See sample Appendix IV.

Flow diagrams tracked searches for studies applicable to the research questions. See sample Appendix V

2.6. The narrative review

Once the feasibility of the study had been established in terms of available and sufficient literature, a narrative review was selected as that most appropriate for this research. Onwuegbuzie and Frels (2016) define a narrative review as a general literature review that not only provides a review of the most important and critical aspects of the current knowledge of the topic, thus expanding and illustrating how a topic is perceived, but also an approach that can identify gaps and contradictions in the literature. Similarly, a narrative review has been identified by Paré and Kitsiou (2017) as a 'traditional' review, undertaken to summarise the extant literature,

illuminating what is already known and providing a comprehensive understanding of current knowledge. For this research too, where focus was on four aspects of the phenomenon under investigation, literature relevant to four different research questions was required. In contrast to a systematic review where focus can be narrow and specific (Snyder,2019), a narrative review offered opportunities to ensure a broader exploration as most applicable.

A benefit of a narrative review lies in the flexibility for the researcher to carry out the review in varied ways, with no prescribed methodology, and no prescribed analysis yet identifying studies offering supporting or contrasting evidence pertinent to the research questions, and potentially developing further questions and insights to gain a wider perspective of the research area. Jahan et al (2016) also acknowledge the less formal approach that typify narrative reviews, with no requirement for reporting methodology, databases employed or search terms used. Additionally, the advantage of a narrative review reflected the limitations arising from the presence of only one researcher with limited time and resources, in the absence of a more widely qualified team to contribute to the analysis and critical review of a range of methodologies, methods and study results.

Although there are advantages in the use of a narrative review, limitations and disadvantages of this approach are recognised. Green et al (2006) posit that a narrative review may lead to a subjective, unstructured selection of review data, lacking inclusion criteria. This may reflect a bias in the selection and interpretation of the material by a researcher, with unknown assumptions and an unknown agenda. Consequently, a narrative review can fail to maximise scope or analyse data

rigorously, perhaps unintentionally omitting significant literature or failing to ensure the validity of included statements. Demiris and Washinton (2019) also consider that narrative reviews are not systematic, lacking protocols to guide the review with the result that the reviewer cannot reach a comprehensive understanding of the current state of the science. Importantly too, a narrative review is not reproducible so that outcomes and findings cannot be replicated and assured.

In order to address the limitations attributed to it, the narrative review was structured to encompassed elements of the framework and guidelines associated with systematic reviews (SRs) where clear and explicit methods are applied to achieve reliable findings (Moher et al., 2009). This approach was selected to take advantage of the flexibility of a narrative review, yet with the structure of a more scientific approach with clearly designated stages. This was intended to ensure a transparently documented process, establishing the objectivity of the researcher and avoiding reviewer bias. A research protocol was followed to ensure that the review was carefully planned and documented , therefore maintaining consistency throughout. In order to do so, the review adopted an approach that included:

- Framing the research questions. (as above)- identifying the key elements of hypothesis to be investigated
- Identifying literature categories to be included.
- Defining the search terms employed
- Delineating the scope of the literature to be examined
- Selecting databases for running searches
- Running the searches
- Screening retrieved articles for inclusion or exclusion with regard to relevance

to the research questions.

- Evaluating the quality of the included studies
- Extracting data relevant to or contributing knowledge about the research questions.
- Analysing organising and comparing data in order to make sense of the literature applicable to the research questions.

The narrative review was set up in the earliest stages of the research but during the on-going investigation, existing and new literature (identified by alerts and further searches) were scanned regularly for relevance. The review was therefore an iterative process whereby data and results were frequently updated as a continuous process throughout the study. During the review, the process was tracked using documentation from De Montfort University (Hudson, N and Law, C. ASS DTP) See Appendices 11-V11.

2.6.1. Literature categories to be reviewed

The literature review included the following electronic and printed types of research studies:

Academic peer reviewed

Primary and secondary literature

Academic journals

Conference abstracts,

Proceedings and papers

Book chapters

Abstracts

Qualitative, quantitative and mixed studies

Government and Voluntary Bodies

Technical papers

Patents

References and citations

Studies of interest to the researcher were identified by the need to best answer the four research questions. Although a range of literature was examined, peer-reviewed journals were prioritised, known to include only articles evaluated by researchers from the same disciplines, ensuring the use of appropriate methodologies and conclusions drawn from sound evidence. In delineating peer reviewed studies, as Hutchinson and Bodicoat (2015) point out, a degree of quality is assured, yet may result in failure to identify alternative, relevant literature. However, the scope of the literature to be examined offered wide parameters within which other articles and papers could be identified, following references and citations included in each article.

2.6.2. Inclusion criteria

- Relevant to the research questions under review
- English language (but not geographically constrained in recognition of the world wide prevalence of PMLD issues.)
- Human communication
- With or without learning disabilities

2.6.3 Exclusion criteria

- Non English papers
- Foreign language participants
- Animal studies
- Newsletters, news releases or memorandums

Although the research is concerned with children and young adults, no age restrictions were employed as Profound and Multiple Learning Disabilities is considered to be a lifelong condition (Hutchinson and Bodicoat, 2012) so that both child and adult studies encompassing the PMLD population were considered to be potentially relevant.

2.6.4. Time span for searches

The time span included was specific to the research question under review. For example, in retrieving literature for Phase 1 (acoustic analysis) a seminal work (Fant's Theory 1970) required a time span of 1970 -2020, while retrieval of early sub vocalisation articles required a time span of 1948 -2020. More usually, a time span 1990 – 2020 was set (to include seminal and concept forming literature relevant to the research questions.)

2.6.5. Types of participants

- English speaking individuals
- Normal, atypical, disordered and dysarthric speakers,
- Adults and children with and without learning disabilities

2.6.6. Defining the search terms employed

Search terms were derived from the individual research questions, varying according to the information being sought. The searches followed the research questions, concentrating on one question at a time, but where articles with some relevance were identified during searches for one of the other questions, they were marked ready for retrieval when needed.

Key words and terms were extracted initially from the research questions, to focus on particular areas of interest, adjusted to the specified part of the research under review. As searches were refined, additional key words from terms in the retrieved literature, abstracts and titles were also employed to extend searches in different directions relevant to the identified research question. References and citations offered links to additional studies. Thus, a range of research terms, key words and targeted phrases were employed to facilitate the different searches . Boolean operators were employed where needed to help with the search strategy. The need to narrow and refine search terms was also apparent and the use of NOT excluded unwanted articles, proving to be particularly useful where search terms identified multiple outcomes for the identified key word. The search term ‘sub vocalization/subvocalisation’ for example applied to animal studies as well as human, and related to inner speech, reading, memory, machine learning, voice assistance devices, singing, schizophrenic, hallucinations, computer interface systems, spectrograms, electromyography, and laryngeal phonation. Where search terms added PMLD, there was a noticeable reduction in results but recourse to literature not including PMLD, or to literature for normal speakers, offered information potentially if not directly applicable to the research questions, particularly for tools and methods.

For Question 1, key words and search terms, separately and in combination were refined as the search progressed and included:

Sub vocal utterances/Acoustic analysis/ acoustic phonetic/ instrumental analysis/ sound/ speech/ whisper/ phonation/ subvocalization/subvocalisation dysarthria/ spectrograms/ vowels/ formants/ consonants/ vocal tract/ waveforms/ frequency/ pitch/ PRAAT/ resonance/

For Question 2, key words and search terms separately and in combination were refined as the search progressed and included:

Speech intelligibility/whisper intelligibility/sub vocalization /Sub vocal utterances/ sub vocalisation/ intelligibility/ listener intelligibility/ listener perception/ delayed/ atypical/ disordered/ sub vocal speech/ naïve listeners/ familiar listeners/ assessment/ tests and measures/ instruments/ chi tests.

For Question 3, key words and search terms separately and in combination were refined as the search progressed and included:

Language/ Linguistic / developmental levels/disordered/dysarthric/ normal/ normative/ speakers/learning disabilities/difficulties/language/speech/expressive/communication/ assessments/communication/language/rules/language/turntaking/prosody/pitch/lang uage procedures/ conventions/rules.

For Question 4, key words and search terms separately and in combination were

refined as the search progressed and included:

PMLD self advocacy/ advocates/proxy/ needs/wants / rights/communicate/ express/ speak/ meaningful/sensible/ language/pre-verbal/pre-linguistic/ views / opinions /perceptions/ ideas/non verbal/pre-verbal/communication.

2.6.7. Selecting databases for running searches

There are various databases incorporating a range of research studies potentially relevant to the research questions. However, the available data are extensive, requiring a progressively narrow focus to identify what is and what is not required. Acoustic analysis of speech on Google Scholar for example, produced 1,710,000 results. The choice of databases therefore was set to focus searches on areas specifically applicable to the research questions. Although all the research questions arose from the data evident in the earliest recordings, the research questions are nevertheless disparate in scope and application, examining different elements of sub vocal phonation and therefore relating to different literature. Consequently, different databases served different areas of interest for the study.

Google Scholar was the first database for all searches, due to the extent of material available with no initial costs. However, this requires the creation of different search strategies comprised of combinations of search terms. Google ranks results by relevancy so that setting the number of pages to be screened can offer consistency across the searches and effective time management. In addition, if required, Google narrows results specific to the area requested, facilitating targeted searches. Following, searches could be carried out via a variety of databases including those

accessible through the De Montfort University A-Z of Databases, enabling citations and references from one database to another to be tracked appropriately. In this way, database results could be reviewed initially, using the title and the accompanying short text.

Subsequent to Google searches, the following data bases were searched:, EBSCO, Science Direct, CINHAL,, IEEE, SCOPUS, PubMed. Search terms were used separately and in combination and broadened in conjunction with OR. EBSCO, ScienceDirect and PubMED provided information related to health and medical issues as did CINAHL, an electronic database for nurses and nurse researchers because the association of PMLD with complex health needs results in medical implications involving health services. Tomlinson et al (2014) stress the need for nursing research into developmental disabilities as specific fields. Moreover, the provision of a range of therapies and support services such as speech therapy, physiotherapy and occupational therapy for PMLD individuals contribute significantly to provision for PMLD individuals and research from professionals in these fields was also available and relevant.

IEEE offered access to technical developments in the field of AAC and acoustic studies, while SCOPUS also incorporated patent databases, particularly applicable to examination of acoustic sub vocal phonation where developments in this field have produced patents relevant to different means of accessing sub vocal utterances.

2.6.8. Running the searches

Abstracts for peer reviewed articles were examined for relevant data for further

investigation. Journals were accessed via the internet both on-line and in printed form and were searched to identify pertinent research studies. Reference lists and citations in both printed and electronic resources identified additional sources of information. Relevant material was also extracted via libraries (accessed if required via a Sconul card) including De Montfort University Library, Hertfordshire University Library and the British Library. In addition to electronic searches, an additional hand search of relevant journals was undertaken during the period of the research. The educational establishments where the researcher worked also proved to be a source of academic and medical publications, many provided by the range of professionals working in special schools. A total of 400 hundred articles deemed to be relevant were identified initially and subsequently filtered for inclusion or exclusion.

2.6.9. Selecting the articles

Two broad approaches can be applied in selection of relevant articles:

- Scanning the search results and extracting at source only those relevant to the research questions.
- Extracting all search results then scanning for selection of relevant results.

The researcher used the first option, extracting at source only those results that appeared to be relevant.

During the search procedures, records were kept to track the searches and the results. See Appendices 2-7.

2.6.10. Screening retrieved articles

The abstracts, introductions or indexes of the identified literature were screened initially, with particular attention to results and conclusions. Appropriate references were selected for further review as abstracts and then screened again for inclusion and exclusion. Literature that did not meet the inclusion criteria (specific to the research question under review) were rejected as were duplicates.

A second scan of retrieved literature enabled further selection of relevant abstracts, papers and articles. Again, irrelevant material and further duplicates were excluded. Of the literature remaining, abstracts as full texts were screened to identify parts relating specifically to the research questions or tangentially to an aspect of research questions considered to be relevant. Further abstracts from retrieved articles were scanned and, where applicable, added to the existing literature. Relevant publications included those where the methodology and study results were specifically applicable to the research questions

While running the initial searches specific to the four research questions, the search results for each question were recorded as a flow diagram, showing the number of records identified, included and excluded, and the reasons for exclusions. See Appendix V: Sample Flow Diagrams

2.6.11. Evaluating the quality of the included articles

Parè et al (2015) recognise that narrative reviews are not formally required to undertake a quality assessment of included studies. In addition, in some studies, the ability to judge quality was limited where methodological details were not reported.

Although there are a range of critical appraisal tools available, particularly for medical research, Katrak (2004) acknowledges that there is no ‘Gold standard’ to ensure the validity or appropriateness of the chosen instrument. Hannes et al (2011) also remind the reviewer that the prospect of a study reaching a required standard is a reflection of the instrument used. The Joanna Briggs Institute's (JBI) Critical appraisal tools (2017) provide a framework for critical analysis often applied to nursing and healthcare studies and for use in SR reviews. Thus, as a tool, some items are inappropriate for the intended critique in different research studies. As Katrak (2004) reports, critical appraisal tools may be research design-specific and thus concerned with items exclusive to that design. In contrast, a generic instrument, facilitates comparison of the quality of different study designs and enables the researcher to synthesise evidence from both quantitative and qualitative studies. Consequently, a generic instrument was used by the researcher to ensure that the critical appraisal instrument would be appropriate for the various review questions and the varied type of studies to be included. Following, the key elements to be evaluated for the literature review were entered into a critical appraisal table to maintain a standardised process. See sample Appendix V1: Critical Appraisal Table. However, some studies do not document all the relevant details, or do not present them clearly, making critical appraisal unnecessarily complex and time consuming. Consequently, not all studies contributing to the research met the requirements of a critical appraisal tool but were nevertheless included for appropriate contributions or information, including tools and methods acknowledged as applicable in other studies. For example, video coding by Nind (1996) appears in a number of PMLD studies, some of which do not meet required measures in the chosen Critical Appraisal instrument.

Some critical analysis tools include a score to indicate the importance and suitability

or otherwise of the study under review. This was not incorporated in the appraisal sheet, intended instead to enable the researcher to assess and consider the suitability of studies (pertinent to the research questions) both for inclusion and for their contribution to the proposed research methods. However,, the presentation of information from the included studies was seen to facilitate the comparison and analysis of gathered data when tabulated.

2.6.12. Extracting the data

A data extraction table was employed to ensure consistency by using identical parameters for each search and therefore avoiding subjective bias by the researcher. Mathes et al (2017) consider data extraction to be a critical step in conducting a (SR) review, forming the necessary basis for the validity of the results and conclusions. An additional benefit of the data extraction table is clear presentation of outcomes, enabling differences and similarities in studies to be more easily observed. See Sample Appendix VII

However, Adie (2013) and Zheng et al (2016) consider that data extraction reflects the quality of reporting in studies, where methods and results may be poorly reported, introducing the risk of omitting or varying interpretation of given information. The reviewer needs to be cognizant of the potential weaknesses in study reports to facilitate retrieval of good quality data. The data extraction strategy was then based on the retrieval of categories of data. Studies pertinent to the research questions were coded manually by highlighting brief notes describing the content. Next, interpretative analysis of the data was carried out, again with reference to the research questions, offering an overall view of the relationships between data and the research

questions and representing the scope and content of associated categories. Thus, relationships between studies became apparent. Correlations could be observed and similarities and differences made evident. Comparison of studies into Intensive Interaction for example, presented with small participant numbers with diverse characteristics (autistic, challenging, institutionalised, socially withdrawn) making outcomes of some studies less applicable to participants in this research. An added complexity in Intensive Interaction studies is the divergence between aims that prioritise communication or social responses or ritualistic behaviours, producing studies where the methodologies are variable, again limiting application to the research participants. In contrast, studies into sub vocal phonation commonly employ normal speakers and standardised measures (EMG) producing a cohesive pattern than can be observed in a table and enabling patterns to become apparent. This then facilitated similarities and differences to become apparent and comparison of data to be undertaken.

2.7. Outcomes of the literature review

As noted above, a narrative review was implemented, intentionally broad in focus to offer an overview of research into the different elements of SV utterances by people designated PMLD. A review framework was incorporated to avoid researcher bias and substantiate outcomes, albeit using an abridged version of some of the stages of a systematic review, yet assessing the strengths and weaknesses of the methods used to obtain the results. However, the review remained broad in focus, seeking relevant research to identify and discuss the existing literature, including methodologies, findings and limits of current understanding. Thus, although the literature review was undertaken to follow a consistent methodology, a more generic

approach often prevailed. The emphasis on establishing a rigorous and valid literature review could exclude the selection of literature that did not met strict criteria yet offered alternative perspectives of PMLD issues. The lack of established literature on the use of SV utterances by people designated PMLD meant that the task of clarifying what was and was not pertinent was not straightforward. The literature review could offer only part of the complete picture. In addition, the diverse nature of the literature to be reviewed (reflecting the diverse nature of the research questions) brought a complexity to the review that had not been anticipated. Moreover, in blending a narrative approach with elements of a systematic approach, the review process required adaptations and tailoring at different points to accommodate the requirements of both, presenting challenges to the researcher. For example, the narrative review sought studies to identify current knowledge and the potential gaps in the literature while the systematic part of the review required a concern with the quality of the literature that potentially rejected studies of interest to practitioners in education. Selecting publications on the basis of quality (across a range of qualitative and quantitative studies) tended to require expertise and completion of databases or pro-forma that recorded details, surplus to requirements. Instead, in prioritising peer reviewed studies, a degree of quality was anticipated, supported by less detailed and systematic analysis. Consequently, selection of studies on the basis of relevance often prevailed, with analysis and issues of quality occurring in response to the nature of the literature. Empirical studies for example differ from theoretical literature or reviews and required different considerations of quality issues.

Despite the complexities of the literature review, 400 items were eventually identified as initially pertinent. As the research progressed , studies were organised and

analysed, drawing primarily on published, peer reviewed research literature subsequently synthesised in relation to each research question. Data from the studies offered triangulation for different evidence sources, merging information to produce an understanding of the current applicable literature and the gaps in the corpus. This also facilitated an understanding and awareness of the wider research evidence, contributing to practice in the four phases of the study. However, although a range of literature was identified specific to the different phases of the research, the lack of studies including PMLD participants using SV utterances restricted results. The need for further and more extensive research into this phenomenon was made apparent. Nevertheless, the extracted data emerging from the review facilitated a narrative synthesis through which to report and discuss the literature relevant to each research question and is presented below.

2.7.1. Review Question 1: Acoustic analysis

Are there any studies which investigate and compare sub vocal utterances by individuals designated PMLD with normative samples where instrumental analysis allows comparison of the acoustic phonetic features of SV utterances with normal speech and whisper?

The exploration of acoustic phonetic characteristics in Phase 1 underpinned the following three phases of the study. SV utterances had to include necessary acoustic phonetic elements of (SV) speech in order to be intelligible (explored in Phase 2) and therefore accessible for exploration of the content and meaningful features proposed to be present (explored in Phase 3 and Phase 4.)

The literature review for Question 1 sought any studies examining the acoustic phonetic features of SV utterances by individuals designated PMLD but none were identified. The presence of sub vocal phonation in PMLD participants appears to be absent from the corpus, not least because the use of meaningful language in any form is not anticipated in this population. Consequently, sub vocal phonation in people designated PMLD appears to be an unknown and unexplained phenomenon. However, research in phonation, both normative and disabled, is extensive, providing an academic basis to the study and a means to focus on relevant and pertinent concepts. The outcomes of studies are presented below.

Extensive research has examined the characteristics of speech so that the review explored studies relating to analysis of normal and sub vocal speech sounds in order to both identify current knowledge and to identify tools and methods to facilitate comparison and analysis of the SV utterances of participants with normal speech and whisper. The rationale for doing so was to identify if features present in SV utterances were also present in normal SV phonation and normal speech and whisper. Were such features to be located, the 'speech like' nature of SV phonation by participants could be compared and analysed, supporting the proposal that the recorded samples were indeed utterances derived from speech sounds. In turn, 'speech like' features were required for utterances to be perceived by listeners as intelligible and meaningful as proposed by the hypothesis.

Initially, the review retrieved 1,050 papers (with no time limit) examining aspects of acoustic analysis of normal, whispered and subvocalized speech, although none were inclusive of SV utterances by PMLD individuals, reaffirming a gap in the

literature. Search terms separately and together included acoustic analysis/ vowels/ formants/ place of articulation/ speech/ whispers/ sub vocalization sub vocal/ normal speech/ disabled speech/ atypical speech/ PMLD. 424 abstracts were retrieved and examined for acoustic phonetic analysis of SV speech, normal speech and whisper for both normal and disabled speakers, comparing and analysing features within these forms of phonation. 57 articles were read in full of which 21 studies presented relevant and appropriate information about subvocalisation to clarify current knowledge in this area and contribute to Phase 1, where acoustic phonetic analysis of the SV utterances were intended to facilitate comparison with normal speech and whisper.

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A scan of the 424 retrieved abstracts identified that 149 studies used Praat as the instrument for analysis and comparison (although not for PMLD utterances) offering methodological guidance for Phase 1 where samples of SV utterances were to be analysed for the acoustic phonetic qualities of 'speech like' features. Confirmation of such features were considered necessary to contribute to intelligibility, which in turn was necessary for exploration of the meaningful and developmental features proposed to be present in the SV utterances

2.7.2. Sub vocal speech

Phonation is defined as 'the utterance of vocal sounds' (Miller-Keane 2003) while the production of audible word sounds is known as 'speech' or 'articulation .'Exploration of the use of meaningful SV utterances by the research participants is predicated upon the assumption that the sounds recorded by the research participants are words, and as such incorporate the features and characteristics known to be present in normal speech and whispers. SV utterances must bear comparison with the production of real

words in order for them to be acknowledged as having the acoustic phonetic features and intelligibility of speech.

Sub vocal phonation is best described as the activation of the speech structures to form inaudible words. Metzler (2009) refers to sub vocal speech as speech in which the articulators operate normally except no sound is produced. Baddeley and Hitch (1974) propose a phonological loop during which sub vocalization is the articulatory control system (inner voice) as a component of working memory. It is integral to a system that is composed of a short-term store in which memory is represented phonologically (but inaudibly) and contributes to on-going rehearsal of stored material.

Normally, sub vocal phonation lacks any communicative significance as it remains inaudible to the listener, below the threshold of normal hearing at 0dB. In order to track sub vocal phonation, non-audible speech recognition systems have used surface electromyography (EMG) to record and recognise signals from electrodes reading signals from the speech musculature and speech structures via the face and neck. Using this approach, a study by Manabe & Zhang (2004) achieved an average recognition rate of 64% for 10 Japanese digits for 10 sub vocal speakers and Maier-Hein et al (2005) achieved a mean recognition rate of 97% using electromyographic recordings with 3 sub vocal speakers.

Similarly, studies into Silent Speech Interface (SSI) systems by Wang et al (2012) and Denby et al, (2010) also used electromyography (EMG) to measure speech musculature activity over time and therefore detect SV resonance and speech movements of the vocal tract and larynx. These systems have been explored as a means to convert the movements of the speech structures to words for command and

control devices or to activate text-to-speech synthesizers. These exploratory approaches are based on the premise that electric nerve signals travel from the brain to articulatory mechanisms including the vocal tract, larynx, jaw, lips and tongue to activate, integrate and synchronize required movements to form words. Jorgensen (2010) reports that the electric signals occur, however quietly the individual speaks, or indeed, even when the brain is 'thinking' words, without speaking them, electric signals are still sent to activate corresponding movements in the speech mechanisms and musculature. Similar activity occurs for normal speakers during silent reading when the speech mechanisms move in response to the reader's internalised reading, but are suppressed so that the voice remains inaudible. Sternberg (2016) too attributes sub vocal phonation to the response of the distinct linguistic areas and neural links that convey the brains stimulus to the speech structures. The structures respond to the brains 'instructions' although the response is insufficient to produce acoustic signals that can be heard by a listener.

Some research has been concerned with developing the use of sub vocal phonation where audible speech is not viable, in voice disorders for example, or where audible speech functions poorly. The medical and surgical implications of sub vocal phonation have been investigated where assistive devices may be used to replace normal verbal output, for individuals who have lost the power of speech. Becker and Bustelo (2006) were awarded a patent for a method of communication intended to operate by transforming sub vocal speech signals into synthesised speech or text via electromyographic (sEMG) signals. (See Appendix VIII Patent US 2006/0129394 A1) The sub vocal speech signals are captured via sensors on the neck and transmitted to a device to read and adapt the signals to either text or audible speech. However, as with other exploratory devices for use with SV phonation, the potential for their use by

individuals designated PMLD has not been explored as language in not anticipated in this population. Nevertheless, such approaches demonstrate the expectation that sub vocal speech can operate as communication via synthetic speech or text.

In a study by Meltzer et al (2008) eleven recording locations on the face and neck were used in order to determine if surface electromyograhic signals (sEMG) operated via speech musculature to facilitate speech recognition, as an alternative to acoustic signals. The word set contained 65 individual words, including numbers 0-10. In a comparison between vocal and sub vocal (mouthed) electromyographic signals, Metzler et al found that recognition of vocalised speech was highly accurate, while recognition of mouthed (sub-vocal) speech was less but ‘still quite high’ (p.2669) scoring a mean recognition accuracy of 96.7% for sub the digit vocabulary and a mean recognition accuracy of 86.7% for the word vocabulary.

See Appendix lX: Metzler et al (2008) Summary of recognition results for both vocalized and mouthed (sub vocal) speech.

Although research into sub vocal phonation has been largely concerned with the exploration and measurement of electromyographic signals, Nakajima et al (2003) describe a speech recognition system that captures a non auditory murmur transmitted through internal soft tissue associated with the phonatory organs. A microphone captures the sounds associated with the vibrations and transfers the signals to a microphone. The approach described by Nakajima et al is not reliant on electromyographic signals, but captures resonance described as a vibration sound associated with the motion of the phonatory organs.

A recent approach to producing speech for individuals who have lost the ability to talk unaided has been developed as a speech decoder that operates by transforming brain signals that instigate the movements of the vocal tract into synthetic speech. Amanchipalli et al., 2019) This research reflects the understanding that the absence of verbal speech is not necessarily an indicator of the lack of inaudible, functioning language. As with the other studies described above, researchers have demonstrated that inaudible yet meaningful language can and does operate even where individuals are unable to speak.

Other investigations into sub vocal communication have demonstrated systems for recording, amplifying and play back of sub vocal utterances. Gould (2006) reported in Sternberg (2016) recorded and amplified sub vocal utterances of schizophrenic patients to demonstrate that the ‘voices’ they reported hearing inside their own heads were in fact their own sub vocal speech.

More recently, Kapur, et al (2018) have developed a device (MIT Alter Ego) that reads neuromuscular signals from speech structures to enable the normal wearer to interface with and control a range of IT devices. The device operates without any audible voice by the user, and without any observable movement of the primary articulators. Instead, words are articulated internally. The purpose of this device is to facilitate a human-computer interaction, intended to augment human cognition and functioning while conversing with the machine. This development acknowledges the potential of internalised speech to operate communicatively, via appropriate devices.

2.7.3. Analysis of speech sounds

Results of the literature review of studies investigating different forms of phonation identified that acoustic analysis is now common place in research studies and recognized as a legitimate means of examining different aspects of speech. Kent et al (2002) report the now widespread usage of digitally recorded speech samples for analysis and advises that acoustic analysis methods are useful for research, considered more objective than some other methods such as articulatory or perceptual rating (Kent, 2019.) Ladefoged (2012) details the analysis of speech sounds, interpreted in terms of the acoustic and phonetic outcomes and also acknowledges that analysis of speech is facilitated by recording the sound for subsequent analysis, providing more information than merely listening to a recording. Therefore, in this study, the acoustic and phonetic analysis undertaken used recorded samples of SV utterances by participants

A scan of the 424 retrieved abstracts identified that 149 articles used Praat as the instrument for analysis and comparison (although not for PMLD utterances) offering methodological guidance for Phase 1. Neel, (2010) P. Martin, (2004) Lansford and Liss (2014) Martens et al (2014) Van-As Brooks (2006) all report Praat (Boersma & Weenink, 2007) as an appropriate acoustic measurement tool for analysis of utterances. Computer software has been developed In order to analyse the phonetic and acoustic characteristics of speech sounds using spectrograms and Praat (Boersma & Weenink, 2007) is a software programme for the scientific analysis of speech, offering spectrographic displays of speech features to show the acoustic and phonetic elements of speech sounds. Praat (2007) is acknowledged as an appropriate tool for the instrumental analysis of both disordered and normal recorded phonation and utterances (Lansford and Liss, 2014; Martens et al., 2013; Van- As Brooks, 2006.)

However, Harrington (2010) considers that there are limitations in the analysis of individual utterances, as proposed for this research, as speech varies according to context, anatomical variations and the idiosyncratic nature of individual utterances. Although this leaves a mark on the acoustic signal it may not offer a true presentation of the principles of speech sounds. However, as in this research, where the comparison between SV and normal utterances are broad rather than discreet, detailed precision was considered to be unnecessary.

The production of spectrograms through Praat software as a means to examine and compare acoustic and phonetic features of SV utterances and normal speech and whispers was supported by the literature. Weismer (2007) attributes the power of the spectrogram to the way in which it reflects not only the activity of the speech mechanism but also what is likely to occur in the ear of the listener. This approach was identified by Hillenbrand and Clark(2001) Perkell et al, 1995, Ladefoged (2012) Weismar (2007) who report the use of spectrograms for the display of formants for comparison, identifying acoustic and articulatory positions.

The literature made clear that vowels and formants are an appropriate means to facilitate analysis and comparison of different forms of phonation for Phase 1. Fant (1970) examined vowel production and established the theory of the source filter model, showing that vowels are the consequence of the voice sound source and the resonator that is the vocal tract, resulting in frequencies known as formants. Formants represent oral tract shapes and Gramley (2010) too recognizes the importance of the source–filter theory for acoustic studies. Ciocca and Whitehill (2013) reviewed acoustic theory of vowels in relation to the source-filter theory of speech production,

offering methodological guidance for acoustic analysis. The data extracted from the review reflected the basic aspects of acoustic theory that underpin the analysis of acoustic data, guiding methods used in Phase 1.

Spectrograph patterns display formants (concentrations of energy) that distinguish speech sounds, facilitating identification of the acoustic and articulatory positioning of different classes of speech sounds (Ladefoged, 2012; Hillenbrand and Clark, 2001; Perkell et al., 1995.) The similarity (or dissimilarity) of production of normal and SV phonation can be observed due to the different acoustic patterns in different classes of speech sounds, relative to the articulatory gestures producing them. Due to the relationship between formant frequencies and the configuration of the vocal tract, spectrograms are the typical means to examine the acoustic features of speech sounds, offering a means to interpret acoustic and phonetic consequences in relation to articulatory performance. Thus, using spectrograms, speech sounds can be identified and mapped, providing the means to instrumentally analyse and compare different utterances and different modes of phonation.

58 studies were reviewed to provide information about the association between formant frequencies and vowel production yet Speake et al. (2012) report the limited number of studies on vowels in comparison to consonants. However, Morrison et al (2013) report a growing body of research that demonstrates substantial spectral change in vowels, offering a means of analysing and comparing speech samples. Fogerty and Kewley-Port (2009) recognise low and mid-frequency spectral energy in vowels as more powerful than that in consonants, offering a discernible comparator for speech and sub vocal analysis.

Yang & Fox (2013) and Recasens & Rodríguez (2016) reported that vowels are produced with acoustic variations (with varying implications for articulatory positions) suggesting that the lack of observed articulation (seen in the participants in this study) may not inhibit or obstruct vowel production. Gerosa et al. (2007) Lee et al., (1999) J. Yang & Fox (2013) reported that vowel precision will increase with maturation as children continue to refine the characteristics of vowels with increasing age. (Auszmann & Neuberger, 2014) This suggested a possible degree of imprecision in SV utterances by children in this research, where younger participants might be expected to produce vowels less precisely than their older counterparts. Analysis and comparison between participants of different ages could further inform this possibility in the longer term.

In addition to the analysis and comparison of SV recorded utterances with normal speech, comparison with whispers was also proposed in order to identify the relationship of the SV utterances to either form of phonation. Sharifzadeh et al (2012) note that whispers have been of limited interest to researchers, having little communicative function. However, in this research, where the phonetic and acoustic nature of utterances has yet to be identified, analysis and comparison with whispers was undertaken. This was because the nature of the recorded utterances was unclear and the assumption that utterances were sub-vocal required clarification if alignment with speech sounds was to be examined. The presence of significant differences between whisper and normal speech is acknowledged in a range of studies. Ito et al (2005) reported formant differences in vowels in whisper and speech, with an upward shift of formant frequencies of whispered vowels compared to the

normal speech . Konno et al (1996) and Jovicic (1998) also showed the shift to higher frequencies for formant frequencies for whispered vowels in comparison to normal speech. Morris and Clements (2002) using a linear predictive spectrum show that the first formant in whisper is higher in comparison to voiced, and some formants are unstable (relative to the sounds produced.) The acknowledged differences in formant locations between whisper and normal speech offered a recognized means of analysis and comparison.

2.8. Review question 2: Intelligibility of utterances

Are there any studies which test the intelligibility of SV utterances by PMLD individuals as perceived by listeners ?

The importance of intelligibility was central to the research. The acoustic features explored in Phase 1 demonstrated the presence of vowels, integral to syllables and therefore pre-requisites for intelligibility. SV utterances had to be correctly perceived by listeners in order to enable any investigation of their properties. Evidence that participants were producing intelligible, meaningful words depended upon the degree to which they could be understood as such. In addition, Phase 3, where utterances were assessed for content and structure required intelligible samples so that words and phases could be assessed, and similarly, Phase 4 required intelligibility to facilitate examination of the meaningful nature of utterances.

Initially, it was apparent that much research has focused on aspects of speech motor control mechanisms (Dworking (1991), Yorkston, Miller, & Strand (1995), Murdoch (1998) and Freed (2000) on the assumption that oromotor non speech activities

illuminate speech production processes. However, emphasis on examination of the structure of the speech mechanisms by oromotor non-speech tasks as significant in speech production has been criticised for the failure to acknowledge the crucial role of auditory and perceptual outcomes and thus intelligibility. Weismer (2004) Gerratt et al (1991) and Netsell (1986) propose that the lack of attention to the acoustic and perceptual characteristics of speech production obscures the importance of intelligibility as a major component of motor speech disorders. In this study, where intelligibility is an important consideration in the analysis of SV utterances, an examination of the literature made it apparent that focus on speech structures and mechanisms lacked relevance. Essentially therefore, research into speech behaviour, not speech mechanisms was undertaken.

A concept central to this research was the degree to which utterances could be perceived as intelligible. The literature review (1990-2020) identified 245 papers for listener intelligibility of sub vocal speech but no studies into SV utterances by people designated PMLD were retrieved because language is not anticipated in this population. Moreover, many studies concerned with intelligibility or silent speech/sub vocal speech recognition reflected medical implications (152 - for laryngectomy for example) because sub vocal speech has no communicative function for normal speakers. However, studies into listener intelligibility tests for both normal and disabled verbal speakers offered methodological guidance , relevant to examination of the intelligibility of SV utterances. Thus, research studies in this area, in conjunction with current understandings of intelligibility offered an understanding of the theoretical and practical approaches to defining and assessing listener perception of SV utterances.

2.8.1. Definitions of intelligibility

Definitions of intelligibility vary, encompassing different criteria or examining different variables(Cruz, 2007) A search of the literature on intelligibility identified the difficulty in reporting a universally accepted standard against which to establish an unequivocal measure of speech intelligibility. (Weismer, 2007) points out that intelligibility is not an absolute. Rather, it is a complex amalgamation of features pertinent to the speaker, the listener and the environment. The interplay of varied elements affecting intelligibility hinders accurate measurement, only reflecting the particular set of circumstances, at a particular time and in a particular place. Efforts to be more specific cannot be reliable. Nevertheless, Weismer (2007) acknowledges that intelligibility reflects the extent to which a speaker's acoustic signal can be received by a listener. Clark et al (2007) concur, agreeing that intelligibility of a speech signal involves more than the capacity of speaker but is also derived from the capacity of the listener to perceive, process and encode the acoustic performance. Thus, while improvements in intelligibility may be a function of variables in the production of the speech signal (Levy et al., 2017., Klien and Flint, 2006;) adaptations in the perceptual competence of the listener have been increasingly viewed as significant.

As the intelligibility of sub vocal phonation has yet to be established and there is a lack of research into this aspect of sub vocal phonation, the literature search was concerned with studies reporting listener perception of normal and disordered speech. The search aimed to establish how best to assess and report listener perception in order to identify appropriate listener attributes contributing positively to the intelligibility of SV utterances.

2.8.2. The role of the listener

The role of the listener in contributing to the intelligibility of SV utterances was made clear by the literature review. The value and purpose of listener tests of intelligibility was evident. Due to the novelty of the phenomenon under investigation, listener intelligibility of SV utterances remains unreported. The necessity for the collection of relevant data was apparent, potentially offering insight into identification of a listener profile best suited to understanding SV utterances.

Studies have shown the ability of listeners to improve their recognition of atypical or degraded speech as a function of perceptual learning. (Francis & Nusbaum, 2009, Greenspan et al, 1988, for computer synthesised speech, Weill, 2001 for foreign accented speech; 1985, McGarr, 1983 for hearing impaired speech.) Thus, a number of studies have demonstrated that listeners adapt over time to a disordered signal by increasing their ability to understand the utterances. Studies across a range of atypical and disordered speech reported some degree of familiarization to benefit listener perception (Hervais-Adelman et al, 2010., Bradlow & Bent, 2008; Clarke, 2002; Clarke & Garrett, 2004; Dupoux & Green, 1997; Greenspan, et al., 1988.) It appears that listeners rapidly adapt to a distorted or accented signal, and also that subsequent attempts to decipher that signal are more successful The same is seen to be the case for disordered speech where researchers acknowledge the positive effects of familiarization as a means of improving perceptual processing of the same speech signal (Liss, et al., 2002; Liss, et al., 1998; Tjaden & Liss, 1995b.) Borrie et al (2011) report the small body of evidence to show that perceptual learning of dysarthric speech is also facilitated by familiarization. This is presumed to occur as a consequence of

the ability of the listener to gain information about the irregularities occurring in the speech, and to map this onto existing knowledge and subsequent experience. However, particular problems may occur with severe dysarthria where variation between speakers is an inevitable consequence of the idiosyncratic nature of this condition.

(Bradlow and Bent, 2008., Liss, 2007). Yorkston, Dowden and Beukelman (1992) identified the need for studies to examine listener training and recent studies have examined the influence of familiarity on listener perception by 'training' or familiarising listeners with dysarthric or atypical speech, prior to intelligibility tests where gains have been reported. (D'Innocenzo, Tjaden, & Greenman, 2006; Hustad & Cahill, 2003; Liss et al., 2002; Spitzer, Liss, Caviness & Adler, 2000.) D'Innocenzo, Tjaden, & Greenman (2006) report positive effects for listeners exposed to word list or paragraph familiarization, and also report positive effects for sentences produced in loud conditions.

As yet, the variations across the reported studies include differences in the number and type of speakers, variations in listeners (naïve or familiar), familiarisation conditions and stimuli used for intelligibility testing. Although there is no definitive report of a familiarization process derived from empirical research that clearly demonstrates effects upon intelligibility, familiarity per se has been acknowledged as significant. Borrie et al (2011) call for further research to develop a theoretical framework to suggest how best such perceptual learning of disordered speech may be facilitated and grounded in current understanding of perceptual processing of dysarthric speech.

The data reflecting the positive effects of familiarity on listener perception had implications for the development of the listener tests of intelligibility planned for Phase 2. The decision was taken to divide the 40 listeners recruited for the tests into two sets of 20 naïve listeners and 20 familiar listeners so that the subsequent effects on test outcomes could be evaluated, However, the decision about the nature of 'familiarity' or 'naïve' was made difficult by the lack of standardised definitions of either term.

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2.8.3. Sample sets

Despite some research outcomes that demonstrate improved listener competence with exposure to disordered speech, gains in perceptual learning cannot be assumed

to occur exponentially with experience. Some regard must also be given to the nature of the samples sets as the severity of the atypical or disordered speech may have consequences for listener perception. Where the severity of disordered speech is extreme, reduced intelligibility has been shown to have an undermining effect on perceptual learning rates (Bradlow and Bent, 2008). Liss (2007) posits that the perceptual processing of disordered speech may be the same as that for healthy speech but the perceptual challenges listeners encounter with disordered speech limits success. Liss (2007) reports that the extent to which listener perception is influenced relates to the degree and nature of the speech disorder. Severe dysarthria challenges listener perception. Adjustment may not occur at all for listeners who hear disordered speech of a severity over a certain level. There are no measurable indices of severity.

This aspect of the literature search raised concerns about the clarity of SV samples and the subsequent influence on intelligibility. Initially inaudible samples once amplified were variable due in part to the quality of the participant's voice. For individuals, respiratory effort varies, producing clear and less clear outcomes. Respiratory difficulties (common to this population) frequently vary the energy available for phonation and therefore the quality of the utterance. Most generally, amplified SV utterances have the quality of a 'hoarse whisper' although they do not meet the definition for whisper which is audible to the normal listener. Some samples are precise and clear, others less so. Hackaday (2019) reports the advantages of recording ingressive speech (producing words as breath is inhaled) over egressive speech where words are produced with exhalation. Ingressive speech does not propel air over the micro- phone so that the recording of air gusts is eliminated. Hackaday describes

this as being as efficient as normal speech and it may be that some participants produce precise results using this mode of phonation. Some individuals move between different modes, producing samples that are often very different in quality and therefore more or less intelligible. Additionally, the effects of the software processing the samples produce inconsistent outcomes on recorded material because the software is not designed to record or process inaudible sound. Consequently, although the presentation of SV samples in this research seeks to ensure that listeners unfamiliar with this atypical phonation can perceive the utterances, the difficulties in producing them clearly must be acknowledged.

2.8.4. Meaningful samples

Hustad (2000) found that intelligibility and comprehensibility of dysarthric speech was increased when listeners had access to extrinsic information, such as topic cues to supplement their communicative efforts. Context contributes to comprehension. Hustad and Garcia J (2002) report that speech that uses meaningful phrases or provide multi-choice options as answers enable listeners to 'predict' according to context and therefore achieve better test results. In contrast, nonsense words or phrases produce lower scores. Research also indicates the relevance of meaningful context where semantic and lexical information aids intelligibility. Interpretation of the word 'bow' is significantly aided by the surrounding context and lexical structure. The positive contribution of subject cues and context to listener understanding has been recognised (Hustad, et al., 2003a., Hustad et al. 2003b., Garcia and Dagenais, 1998., Yorkston, Strand, and Kennedy, 1996) and has implications for the presentation of samples in intelligibility testing.

The recognition of the importance of context in facilitating intelligibility is supplemented by outcomes from research studies that acknowledge the role of non-speech behaviours that support and clarify the spoken word, The positive implications for intelligibility of visual information provided by the speaker's face (Keintz et al., 2007) and body language and gestural cues (Wolff-Michael Roth,2016., Garcia and Dagenais, 1998.,) has been recognized, behaviours conspicuously absent in children and young adults designated PMLD. Behaviours typical in the normal speaker are frequently non-existent or idiosyncratic in individuals designated PMLD, reflecting the disordered effects of motor, sensory and physical impairments. Facial expressions and/or eye contact may be absent or lacking significance or even misleading. As a consequence, despite the known advantages of listener access to the speaker's facial cues and body language, recourse to presentation of SV utterances as audio samples only was inevitable. The use of digitally recorded audio samples of SV utterances, selected for clarity in sound offered a legitimate means to assess intelligibility.

2.8.5. Assessing intelligibility

In order to design and conduct listener tests the literature search explored the variety of means by which to do so. The search revealed a range of approaches to intelligibility testing but, as Kent (1992) acknowledges, two people may share a common understanding of what is meant by intelligibility, but use different ways to measure it. The literature search emphasised the diversity of speech intelligibility tests, employing different methods to ascertain outcomes that result from the interplay of different variables. Difficulties in maintaining standardised protocols in research studies have led to the use of a range of tasks to control for confounding variables. Consequently, different methodologies may be examining different aspects of intelligibility so that, for

example, transcription methods may determine intelligibility by the correct number of words recovered by a listener, while studies that seek to establish the degree to which speech communicates meaningfully is concerned with functional intelligibility, where listeners need only grasp the speaker's intent, even where some words are unintelligible. Despite the extensive range of approaches to intelligibility testing, the literature search provided information about approaches commonly employed with atypical and disordered speech, where listener perception might be most challenged.

2.8.6. Rating scales

Efforts to standardise protocols often make use of listeners to rate speech samples by attributing a number to predefined descriptors, to rank or rate the degree of intelligibility against a specific scale. The content of the pre-recorded samples is generally given to the listeners in order to provide a standardised set of stimuli. E.I.A Scales (equal appearing interval scales) associated with a descriptor (for example 1 = completely unintelligible to 7= completely intelligible) employ this approach (Darley et al 1969.)

Percentage estimates require listeners to estimate the number of words that they consider to be intelligible within a speech sample. As with rating scales, percentage estimates rely on listener responses that reflect perceptual variations. Variations in listener skills, familiarity, hearing competence and linguistic experience, all have implications for inconsistent results and Weismer and Laures (2002) identified difficulties in comparing results between studies without standard referents. A further weakness in these methods is the assumption that all words have the same value in terms of conveying meaning (which may not be the case) and all perceptual abilities of the listeners are equal.

Similarly, DME scales (direct magnitude estimation) require listeners to assign values to indicate proportional differences in samples in relation to a known standardised sample. However, for disordered speech, Whitehill, Ciocca, & Yiu, (2004) provide evidence that listeners using scaling techniques fail to distinguish between the degree of speech distortion and intelligibility, producing unreliable outcomes. Weismer et al (2001) found variations in intelligibility scores for dysarthric groups using DME scaling, whereas transcription of single words did not differentiate intelligibility between different dysarthric groups. Weismer (2007) summarises the many complexities of intelligibility tests by acknowledging that intelligibility is affected by so many variables that no single measure can give a complete index of it. Instead, tests and assessments must be seen as a snapshot of intelligibility, specific to the time in which it occurs, during which a particular set of listeners respond to particular stimuli. Thus, Weismer (2007) considers that efforts to generalise outcomes must be seen as both dangerous and probably inaccurate.

Despite the acknowledged difficulties in assessing intelligibility, the need to measure the extent to which listeners could perceive SV utterances as intelligible prompted an examination of the tools and methods advocated by pertinent research studies, albeit not PMLD specific.

2.8.7. Orthographic transcriptions

Millar (2006) reports sentence transcription tasks as commonly used for a representation of real life impairment and maximum face validity and this approach has been used to measure intelligibility in a range of studies. (McAucliffe, Ward and

Murdoch, 2007., Dagenais et al., 1999., Tjaden & Liss, 1995., Southwood and Weismar, 1993.) Thus, orthographic transcription of the acoustic signal alone could offer pertinent insight into listener intelligibility without reference to other variables (Hustard, 2006)

Orthographic transcription enables researchers and practitioners to gain a quantitative measure of the number of words understood by listeners. Research studies typically employ a between subject design where listeners are randomly assigned to one of a number of listener conditions and complete transcription tasks of speech samples, where correct word recovery produces a quantitative measure of intelligibility. The Sentence Intelligibility Test (S.I.T) (Yorkston, Beukelman and Tice, 1996) and The Assessment of Intelligibility of Dysarthric Speech (A.I.D.S, Yorkston and Beukelman 1981) employ this methodology. However, variability over time (even within the same day) can compromise the outcomes. Test –retest variability for the word task in the A.I.D.S. test is below 5% while that for the sentence test – retest task is between 9%-11%. Yorkston and Beukelman (1981) recommend that an initial baseline control be established for the individual against which to measure further samples when applying these assessments.

Although orthographic transcription is commonly employed in intelligibility tests and reading and transcription of words and sentences offers a degree of standardisation, this approach may not reflect the reality of communicative exchanges. Functional communication does not require the listener to extract meaning from each separate word. Sussman and Tjaden (2012) propose that word or sentence transcription may fail to identify the extent to which linguistic, semantic and acoustic elements convey

information to the listener. Intelligibility is a function of listener knowledge as well as listener experience. Hustad and Garcia (2002) report that semantic and lexical information provided by the speaker can contribute to intelligibility, and benefits accrue from the use of topic and alphabet cueing as positive contributors to understanding (Hustad, Auker et al., 2003; Hustad, Jones, et al., 2003) Consequently, intelligibility may be positively aided by clear identification of the subject and content.

2.8.8. Comprehensibility

Listener comprehension has been usefully defined as the listener's ability to interpret the meaning of messages without regard for accuracy of phonetic and lexical parsing (Hustard& Beukelman, 2002.) Hustard (2008) found that measures of listener intelligibility and comprehension offer a better description of the information contained in dysarthric speech than intelligibility scores alone. In a study of the relationship between listener comprehension and intelligibility scores for dysarthric speech associated with cerebral palsy, Hustard (2011) proposes that a more complete description of the information bearing capacity of dysarthric speech may be provided by listener comprehension in conjunction with intelligibility measures. Thus, data on comprehensibility could potentially offer further insight into the information bearing capacity of SV utterances

2.8.9. Language conventions

A concern with how SV utterances could operate as language was engendered by the literature search, which emphasised the significance of underpinning rules and conventions that aid both the meaning and intelligibility of normal speech. Intelligibility

is a crucial component of SV utterances but cannot operate in isolation. Attention to the process as well as the content led to a focus on research studies into those features that facilitate the meaningful operation of language as communication. SV utterances needed to be shown to be more than the production of words. Success or disruption of the intelligibility of the communicative process may be vested in processes underpinning the interaction, rather than the intelligibility or otherwise of the acoustic performance. Identification and examination of SV utterances offered the means to compare and contrast adherence to rules integral to normative speech. The literature search identified two areas recognised as fundamental for the use of language as intelligible, effective and meaningful communication. Turn taking and prosody were viewed as significant.

2.8.10. Turn taking

Turn taking is described as a means of maintaining co-constructed turn and utterance production to accomplish communication competence in both normal and impaired speech. Kaye (1977) in the early examination of mother/infant pre-verbal interactions stressed the essential role of turn taking, proposing that turn taking is a vital ability that must be attained via non-verbal sequences before language can develop. Bloch and Wilkinson (2004) using Conversational Analysis (CA) report the management of turn taking in conversations with AAC (Augmentative and Augmentative Communication) users, while Bloch and Beeke (2008) examined the collaborative activities that enabled turn taking in families dyads where the speech of one individual was impaired. Turn taking ensures that partners in a dialogue operate reciprocally while facilitating joint focus of attention and mutual understanding. With regard to SV utterances, the

competence or otherwise of participants in turn taking presented a feature identified by the literature review as significant for intelligibility, with repercussions for communication.

2.8.11.Prosody

The influence of prosody on the intelligibility of utterances was highlighted by the literature search. Ashby and Maidment (2005) and Ladefoged (2005) define prosody as the intonation, stress and rhythm of speech that incorporates features of the utterance that attribute meaning beyond that of the individual word, facilitating interpretation of utterances by underpinning signposts to meaning. Ashby and Maidment (2005) note that intonation uses changes in pitch of the voice to facilitate interpretation of utterances, so that the delivery of an utterance may carry information about the speaker's intent in using a command, question or statement for example. Prosody can attribute emphasis to a word or words, contrasting or focusing on different elements of the utterance. It identifies the speaker's intent, such as capturing anger, excitement or disbelief by the way in which the utterance is emitted.

The appropriate and inappropriate use of intonation has been examined. Dysprosody is commonly acknowledged as a perceptual feature of dysarthria (Duffy 2005, Lowit-Leuschel & Docherty 2000., Darley, Aronson and Brown 1975b., 1969a) typified by monopitch and monoloudness in conjunction with abnormal variations in rate, and the inability to place stress appropriately on words and sentences. Failure to use prosody appropriately has negative implications for intelligibility and may indicate the failure of the speaker to share and understand the underpinning rules that guide communication.

2.9. Literature review Question 3:

Are there any studies which examine the linguistic and developmental levels of PMLD individuals beyond 0-24 months?

Phase 3 explore the linguistic and developmental levels revealed by the structure and content of participant SV utterances. This was a necessary aspect of the research because, although utterances could be intelligible, containing required acoustic phonetic features, they might be lacking the correct structure and content to be meaningful at levels beyond 0-24 months. Where the structure and content can be assessed at levels developmentally and linguistically appropriate for those beyond infancy, the individual producing the utterances can be similarly aligned. Moreover, the production of echolalic words and phases is not uncommon in individuals with learning disabilities (Stiegler, 2015) necessitating evidence that utterances did operate meaningfully and were not simply 'copied' from those around the participants.

The ability to produce SV utterances is predicated on the assumption that the research participants have acquired the necessary linguistic and developmental levels to do so., The literature review identified an absence of literature examining linguistic and developmental levels beyond 24 months for individuals designated PMLD. The characteristics of pre-linguistic and profound developmental delay attributed to this population excludes them by definition from attributes associated with stages beyond infancy, where the designation of severe learning disabilities would then apply.

Language and cognition beyond 0-24 months is not anticipated and not assessed.

This rationalized the absence of studies into the content of their language, but also illuminated the failure of assessments to indicate their abilities. This is an important consideration for the research , where participants are designated PMLD in the absence of assessments able to determine precisely their level of linguistic and developmental functioning, thereby obscuring the linguistic competencies of the research participants while maintaining the label of 'pre-linguistic'. A range of studies identified problems in assessing this population, potentially offering an explanation for the impediments in recognizing and attributing linguistic abilities to the 20 research participants. Where SV utterances could be demonstrated, previous assessment outcomes appeared to have been imprecise. Consequently, a review of studies exploring assessment issues was undertaken to explore the reasons for the failure of the research participants to achieve assessment outcomes commensurate with the demonstration of their SV utterances. Their inability to do so (prior to recording utterances) both designated and maintained. the attribution of PMLD.

2.9.1. Assessing people designated PMLD

Tassé, Nakken & Vlaskamp, (2007) propose that assessment of individuals designated PMLD is problematic where intellectual impairment is so profound. The Association for the Scientific Study of Intellectual Disability acknowledge that no standardized tests are available to provide a valid estimation of the intellectual competence of PMLD individuals. Luckasson, & Nygren (2013) consider that accurate measures of cognition are not possible where cognitive performance is so extreme. The implications for the research questions are significant, predicated as they on assumption that the participants are producing meaningful utterances that exceed the developmental and linguistic levels attributed to them. In order for such utterances to

be present, individuals must operate at levels beyond that of an infant, where language acquisition is known to occur. However, In the absence of appropriate assessments, individuals are designated as profoundly developmentally delayed, operating at levels prior to language acquisition. Consequently, the difficulties with assessment of individuals designated PMLD was explored, seeking to identify why the attainment of language by the participants is obscured Consequently, in order to demonstrate that participants had acquired linguistic and developmental stages where language could operate, Phase 3 first explored why current assessments (or lack of them) refuted this possibility.

A review of assessment approaches for PMLD individuals revealed the complexities of enabling test measures and test materials to be used in a meaningful way where responses may not be physically apparent or observed. An assessment of PMLD individuals to use language is hindered by the absence of assessments that can elicit observed responses. The current belief that language is absent is supported by the inability of PMLD individuals to show otherwise, in conjunction with their inability to demonstrate developmental abilities beyond those of infancy. Consequently, a review of the literature on the assessment of PMLD individuals was undertaken, including the literature examining the requisites believed necessary for language to develop, where failure to do so is assumed to be indicative of pre-linguistic levels.

Nakken and Vlaskamp (2007) acknowledge the current lack of internationally agreed assessment procedures to confirm or disconfirm the intellectual ability of individuals designated PMLD, where the complexities of separating the core characteristics of limited intellect from a range of other impairments prevail. The range and type of

impairments evident in the majority of PMLD people obscure intellectual performance, presenting a less capable individual than might otherwise be anticipated. Complex health needs where severe physical and sensory disabilities are present obstruct behaviours that might otherwise facilitate assessments (Mansell, 2010; Vlaskamp, Hiemstra, & Wiersma, 2007)

2.9.2. Complex health needs

In addition to the profound learning disabilities associated with the designation of PMLD, there is relationship with health that has negative implications for assessments efforts (Nakken & Vlaskamp, 2007, Vlaskamp, Hiemstra, & Wiersma, 2007.) Every Child Matters: Change for Children (2004) refers to a severe medical condition as characteristic of PMLD individuals, often categorised as complex health care needs (NHS 2020, Welsh Assembly Government 2006, Hogg 2004.Bellamy et al 2010) such that PMLD individuals are liable to experience complex health issues associated with particular aetiologies Mansell (2010) refers to the implications for individuals where multiple disabilities including visual, motor and sensory impairments that severely restrict and limit the interaction of the individual with the social and material world around him/her. Although there is often no specific condition recognised as a causal link, there is a variety of aetiologies associated with the health issues, including genetic abnormalities and pre-and postnatal trauma. For some participants in this research, issues about respiratory health are prominent, while health concerns in others relate to epilepsy, reducing their ability to focus and interact with those around them. These , in conjunction with physical and motor impairments restrict and inhibit freedom of movement and visual and sensory difficulties restrict responses to assessment strategies.

With reference to individuals designated PMLD, Imray (2008) proposes that the greater the degree of intellectual impairment, the higher the chance of attendant multiple physical impairments, frequently compounded by complications (Nakken & Vlaskamp, 2007) that hinder efforts to elicit responses to test measures. Garner (2009) reports the commonality of visual impairment in PMLD individuals making access to visually presented test materials problematic. Vlaskamp, Hiemstra, & Wiersma, (2007) also report the high incidence of very limited mobility, with additional problems in the use of upper limbs such that responses such as reaching, pointing, handing objects to the assessor are severely restricted. Visual, hearing and dual sensory impairments are another common feature of this population that has been recognised (Avenues et al 2001; Fellinger, Holzinger, Dirmhirn, Dijk, & Goldberg, 2009.) often unreported (Fellinger, et al 2009), so that assessors cannot correctly judge how best to carried out test procedures that will be accessible to the child or adult. Test measures and test outcomes are therefore compromised.

A further complexity affecting assessment of PMLD individuals is that demonstration of their communicative and cognitive abilities are frequently outside the normal parameters ascribed to particular developmental stages or levels. Simmons (2019) notes that sensory and physical impairments can result in the development of idiosyncratic or unconventional behaviours (Simmons, 2015, 2018, Grove et al 1999, Fyfe, 1980.) reflecting not only the inability of the PMLD individual to meet the requirements of those around him/her, but also the limitations of their own social and educational experience. The nature of their physical and sensory impairments inevitably restrict life and educational opportunities such that inability to develop

‘normal’ responses may instead contribute to alternative behaviours not generally recognised.

In addition to the indicating the extreme difficulties in assessing people designated PMLD, The lack of studies into the content and structure of their language reflected the assumption (reinforced by the absence of assessment approaches) that PMLD individuals are pre-linguistic. In the absence of assessments to identify developmental and linguistic levels concomitant with language acquisition, the literature review made clear that a range of authorities and practitioners identify features and characteristics in this population that maintain the assumption of their profound limitations. In particular, attributes believed to be relevant for language development and linguistic competence are considered to be very limited or absent in people designated PMLD. The literature review explored this proposition, seeking to clarify the reasons for researchers to attribute pre-linguistic characteristics to this population.

2.9.3. Pre-requisites for language development

As reported above, the proposal that participants in this study can produce meaningful SV utterances runs contrary to general understanding of the proficiencies of this population. The literature review identified the understanding that individuals designated PMLD fail to attain pre-requisites believed necessary (but not sufficient) for language to develop (Barber, 1998., Grove et al, 1999., Piaget,1962, 1952., Vlaskamp, 2005a,) The literature review explored the basis for this assumption and the implications for the research participants.

That language develops in normal children in conjunction with the development of

necessary pre-requisite cognitive stages derives from Piaget's (1952) theory of cognitive development. Coupe O'Kane and Goldbart 2016, acknowledge that profoundly disabled children appear to progress through the same sensorimotor stages as do normal children, as described by Piaget (1952.)

Piaget (1952) proposes that normal children pass sequentially through four stages of intellectual development, the first of which is the sensorimotor period lasting from birth to approximately 24 months, the period believed to be characteristic of the developmental level of PMLD individuals. (Hogg, 2004., Imray, 2005., Lacey, 2016.) During the sensori motor period, the normal infant gains initial understanding of concrete objects and, towards the end of this period, progresses to the recognition and understanding of more abstract, symbolic forms of representation such as language in the form of words. Woodward (1969) first demonstrated the association between PMLD developmental levels and Piaget's six stages of sensori-motor development, thus placing the PMLD individual within a developmental framework of infancy, where functioning could be assessed against a standardised norm

2.9.4. Concepts necessary for language development

For many years, the acquisition of the concepts of intentionality and object permanence have been seen as necessary (although not sufficient) for the developmental of meaningful language. (Vlaskamp 2005a, Grove et al, 1999, Barber, 1998, Piaget,1962, 1952.) The presence or absence of these concepts is presumed significant, their absence contributing to the presumed failure of this population to acquire language; their presence facilitating language development. Consequently, the ability of PMLD individuals to produce meaningful utterances pre-supposes the

acquisition of those concepts of intentionality and object permanence, as with normal infants.

2.9.5. Intentionality

Piaget (1952) delineates the significance of intentionality as an indicator of intelligence whereby the normal infant establishes goals prior to action to achieve such goals (Adamson 1996). Intentionality enables the infant to recognise that his/her actions affect the material and social world and such actions can be intentionally performed. This enables the infant to recognise that communication acts too, can operate intentionally and have consequences. Imray (2014) acknowledges the significance of intentionality, similarly recognised by Goldbart (2016) who reports that a degree of cognitive intentionality is required for the development of communication. This enables the infant to understand his/her effects on both the environment and on the behaviour of people. Intentionality is recognised as a cognitive concept to facilitate the development of intentional communication, assuming evidence of the first to precede demonstration of the second. Acquisition of the necessary cognitive structures facilitate linguistic competence. The association between levels of cognition and symbolic means of communication were reported by Gibb Harding and Golinkoff (1979) in a study to identify the Piagetian stage at which pre-linguistic vocalisation in normal infants were intentionally used to communicate. Gibb Harding and Golinkoff found a significant relationship between Stage 5 causal development level and the intentional use of such vocalisations. Their results substantiate the long held understanding that stage 5 causal development is a necessary requirement for the use of intentional vocalisations as communication.

The significance of intentionality predisposes those working with PMLD individuals to find evidence of its presence prior to expectations of language acquisition. Carter and Iacono, (2002) report that for PMLD individuals who lack the capacity to interact easily with their environment, evidence of intentionality may not be demonstrated by external acts and the assumption that it is lacking, can persist so that communication and language are not anticipated. Where PMLD individuals fail to demonstrate such intentionality, their ability to communicate on their own behalf is considered improbable due to their presumed failure to recognise that particular behaviours will communicate. Rather, practitioners and researchers in this area commonly propose that people designated PMLD are dependent upon their partner in an exchange to attribute communicative significance to their acts. Barber (1998) identifies people with profound intellectual impairments as being likely to be pre-intentional communicators, relying on their partner in an exchange to attribute meaning to their actions. Barber (1998) also contends that, due to the level of intellectual disability, PMLD learners are unlikely to understand pictures or symbols. They may be described as being pre-symbolic as well as pre-intentional communicators. Grove et al (1999) concur in viewing communicative abilities of PMLD individuals as primarily pre or proto-symbolic, including many idiosyncratic and subtle behaviours which communication partners interpret through the use of context and prior knowledge. Similarly, Vlaskamp (2005a) identifies the need of PMLD individuals to rely on communication partners to interpret or attribute meaning to unintentional communication acts, often pre verbal and/or non symbolic.

The view that PMLD people generally lack cognitive and communicative intentionality is challenged by Olsson and Granlund (2003) who distinguish four levels of intentionality in pre-linguistic individuals, ranging from a lack of awareness of the

behaviour of others to an awareness that others can be intentionally used as communication partners and to achieve desired goals. Grove et al (2001) consider that intentionality may exist, yet not be demonstrated by external acts where difficulties in assessing behaviours as intentionally communicative or otherwise abound, due to the physical and sensory impairments of individuals. However, the increasing use of IT technology can offer some solutions to problems in testing intentionality in severely impaired individuals. Watson (2012) advises that, if given required support, PMLD individuals can learn to understand and control at least a limited environment, thereby providing evidence that they have attained particular cognitive levels and facilitating assessment of intentionality. Despite physical and sensory impairments, individuals designated PMLD can be shown to act in order to cause intended outcomes, but the means by which they do so must be structured and responsive to their particular impairments. Goldbart and Caton (2010) and Mansell (2010) refer to the role of switch based approaches to facilitate 'cause and effect learning' where the individual learns that his/her actions on the switch can have intentional consequences. Where such intentionality can be demonstrated, via adapted assessment materials, the existence of intentionality as an acquired concept may be evidenced.

2.9.6. Object permanence

Object permanence (the recognition that objects and people continue to exist when no longer visible to the infant) indicates that memory is developing and the child is mentally representing objects (Piaget 1954., Shinskey and Munakata,2005), Words can then operate as representations, so that mental representation is evocative memory. Piaget (1954) identified the acquisition of object permanence to occur during infancy, at 7 months (Huitt and Hummel, 2003)

The limited number of research studies in the literature to attribute intentionality to individuals designated PMLD compares to the lack of research studies to attribute object permanence to this population. People designated PMLD are thought to be unable to demonstrate object permanence, without which the meaningful use of words cannot develop. Evidence for the development of object permanence can be shown by the infant's ability to visually follow or reach for objects that have moved out of sight.The infant retains an internal image of the object, albeit no longer present. Assessments used with individuals designated PMLD often confound efforts by them to demonstrate acquisition of object permanence by their inability to respond to test requirements (reaching or visually following, for example.) Physical and visual impairments severely restrict responses. Their failure to act is assumed to reflect their inability to demonstrate a grasp of the concept. Scores on tests and assessments are frequently negligible, reflecting impairments and disabilities while obscuring competence that cannot be physically displayed.

Although object permanence can appear to be lacking, other means of observing behaviours and responses can and do indicate developmental stages not evident in test conditions. A University of Bristol report (Watson 2012) proposes that the reduction in a startle response to a new toy or unexpected happening over different time periods demonstrates longer term memory. The child is less startled as she/he remembers the previous experience. Memory is developing. Repeated experiences can be presented without requiring either visual or physical activity on the part of the child or adult, as other responses can be observed. More demanding of the individual is physical response to demonstrate object permanence, apparent when the individual attempts some physical movement to show awareness of a hidden object. An

observable behaviour to indicate that s/he is clearly cognisant of its continued existence, even when not visible shows that an internalised image is present and the individual is mentally representing objects. Where the child cannot be observed to attempt to see or activate hidden objects due to physical and visual impairments 'People Permanence' can demonstrate the same concept. If the child responds to the presence or absence of his/her partner in an exchange, he/she is clearly internally representing the partner. The individual shows an awareness of something or somebody no longer immediately present. Object or people permanence can be shown to be developed or developing.

2.9.7. Social development in individuals designated PMLD.

In addition to the acquisition of cognitive concepts, the development of certain social behaviours have been proposed as necessary for the development of language and communication. Harding (1983) proposes that intentional communication is derived from the amalgamation of cognitive abilities with social activities. Clarke (2017) acknowledges the social behaviour of infants where learning occurs in a social context, through interactions with adult partners. Adults lead and shape non-verbal exchanges with infants, providing the framework for the exchanges and facilitating the infant's communicative responses. Where evidence of the ability to operate in this way is lacking, the expectation that language will develop is negated.

Early research into normal mother infant interactions in the 1970's offer theoretical foundations for the importance of pre-verbal competencies as precursors to later language development (Brown,1973; Bruner 1975.,Trevathen,1977). An examination of how such interactions facilitate language suggest developmental parallels between

normal infants and PMLD individuals, believed to operate during the stages of infancy despite chronological disparities.

2.9.8. Theories of social development in infants

Theoretical frameworks for social aspects of communicative competence in infancy were developed during the 1970's and 1980's when researchers examined pre-linguistic interactions between normal infants and mothers during the sensorimotor period (Bower, 1977; Jones, 1977; Brazelton, 1973; Schaffer, 1971) Examination of the content and nature of normal mother infant behaviours identified the crucial role of nonverbal interactions during which the infant learnt the process as well as the content of a communication. Researchers proposed that pre-verbal interactions provided vital experiences to facilitate the development of later language. Interactions were the means by which the infant learnt the rules and shared understandings that enable language to develop and function (Bower, 1977; Trevathen, 1977; Brown, 1973; Bruner, 1975; Schaffer, 1977.) Thus, certain acts have communicative significance (smiling, eye contact, joint focus of attention, for example) and the infant learns to recognise and use these during pre-verbal exchanges.

Fyfe (1980) refers to maladaptive transactions where individuals designated PMLD may lack the competences that a normal infant brings to an interaction – or may lack the means to demonstrate such competences. Bower (1977) proposes that inappropriate responses by the infant may, in turn, produce the malevolent distortion of his/her partner's responses. Stern (1974) p.26 refers to 'mis-steps in the dance' to describe such failures as detrimental to the outcome of the exchange. Similarly, the contribution of people designated PMLD to pre-verbal interactions, believed to be

significant for language acquisition, can appear to be lacking or inappropriate. Where this occurs, the individual is believed to be rendered communicative only by the actions of their more sophisticated partner who consistently attributes communicative significance to what is assumed to be unintentional reactions. Typically therefore, individuals designated PMLD are considered reliant on their partner in the exchange to bestow intention on their efforts. They are presumed to be developmentally delayed in their functioning and understanding of the purpose of communication and described by researchers as 'pre-intentional.' (Bellamy et al, 2010., Mansell, 2010., Hogg 2004.) Their inability to demonstrate social responses in the form of eye contact, joint focus of attention or reciprocal turn taking can be taken as indicative of delayed developmental levels, prior to those deemed necessary for language to occur.

2.9.9. Language assessment

Where the use of SV utterances could be demonstrated by the research participants, the level at which they did so offered an analysis of SV utterances as an innovative means of assessing the developmental and linguistic levels of the research participants, for whom other assessment measures were extremely problematic. The literature was examined for research studies that provided information about current language assessment processes appropriate for children during their early years or for those for whom developmental delay caused them to operate during this period. Due to the presumed developmental delay in individuals designated PMLD, only assessment procedures addressing early years 0-5 were considered. These would encompass the period 0-24 months attributed to PMLD individuals and provide reference to higher developmental stages (0-5) if they were present.

As participants were conspicuously unable to produce audible verbal speech, consideration of assessment procedures was restricted to language use rather that speech production. The assessment of verbal performance, including articulation and pronunciation, was not possible. Concern was with current understanding of stages, levels and competencies in language acquisition and use, albeit initially inaudible.

The literature review identified a range of measures are available to examine the development and complexity of language performance, but the application of formal tests for the population designated PMLD can be problematic, not least in terms of the practical difficulties. Many tests include elements that elicit responses in relation to visually presented material, (CELF 4 for example) and remain inaccessible to participants with visual impairments. Other tests are 'Toddler' specific (Rossetti Infant Toddler Language Scale 2006) assessing pre-verbal and early verbal abilities in infants up to 3 year olds, including production of audible responses that are absent in individuals designated PMLD. In contrast, language sample analysis where competence is assessed simply by the language used has been promoted as preferential to formal testing (Dunn, et al,1996., Lund & Duchan, 1993., Millar, 1996.) Hewitt et al (2005) note that critics of formal test procedures advocate language sampling as a means of examining early years language development. This approach had the added benefit of facilitating descriptive and analytical comparison of normal language and disordered language, enabling this research to draw upon existing, standardised assessments and descriptions of both normal and language impaired criteria. The review also identified the advantages of language sampling as a means to focus on how individuals communicate under natural conditions in the real world (Constanza-Smith, 2010) supporting the use of spontaneous participant SV samples

for language assessment measures.

2.9.10. Mean length of utterance

A commonly used standard index for linguistic competence that uses language sampling in children up to 5 years is Mean Length of Utterance (MLU) and relates to the length of words in utterances produced. MLU is now a well-established measure in assessment of child language development. MLU originally referenced mean length of utterance in words (MLUw) prior to Brown's (1973) introduction of mean length of utterance in morphemes (MLUm) after Brown (1973) correlated MLU with morphological and syntactic skills in child language. Subsequently, MLUm has become an established measurement of a child's language development, although MLUw also remains in use. A comparative study by Parker and Brorson (2005) using typically-developing, English-speaking children found that that MLUm and MLUw are almost perfectly correlated so that, in as far as MLU may be applied to SV utterances, either can be considered.

Seminal work by Brown (1973) provided a normative account of stages in language development such that the presence and use of language features in SV samples could be examined to identify the different levels of linguistic development in the research participants. Rice et al (2005) in 2 studies examining respectively the concurrent validity and temporal stability of MLU equivalency between children with Specific Language Impairment (SLI) and typically developing children, report that MLU appears to be a reliable and valid index of general language development in children from 3 to 10 years old. Subsequently, Rice et al (2010) examined aged referenced MLU for both normal and language impaired children, and concluded that MLU is a

reliable and valid measure of language acquisition in both cases, using standardised norms for normative speech and language. In contrast, critics of MLU as an assessment measure note that language sampling is infrequent beyond the pre-school years (Hewitt et al 2005) where adequate data reference sets are lacking. Despite these disadvantages, use of MLU with a population where language development up to 5 years is sufficient for demonstration of meaningful content, MLU offered preliminary description and examination of SV language by research participants. Where SV language appears to be above the 5 year stage, further research is needed to clarify the nature and extent of acquisition, currently beyond the remit of this study.

2.9.11. Developmental Milestones

Developmental milestones are commonly referenced in normal speech and language as indicative of stages in language and developmental progression. Developmental milestones are catalogued (National Institutes of Health 2009) and provide guidelines and criteria against which language acquisition and use can be assessed. Some use of milestones by researchers have been employed to track speech and language impairments or delay against acknowledged milestones (Sharpe and Hillenbrand 2008.) Developmental milestones include syntactic milestones that can be related to ages and stages of normal child development (Oller et al 2014.) indicative of the ages and stages at which particular language forms are anticipated for normal children, where the development of grammar, vocabulary and sentence structure enable individuals to use language meaningfully (Bird and Buckley 2001.)

The literature search indicated that developmental milestones have not been the

subject of extensive research studies but stand as descriptive stages of child language acquisition, against which to examine language acquisition and use. The clarity of the descriptors offered an accessible and informative view of early language for participants, parents and carers, for whom measures such as MLU lacked familiarity and transparency. A match between language acquisition and content in normal and SLI (speech language impaired) children and the research participants could be anticipated, providing standard milestones as a means to describe and catalogue data. As noted above, as audible speech is atypical for this cohort, comparisons with developmental milestones in speech acquisition were not undertaken.

2.10. Performance Levels

The research participants were assessed by their teachers (prior to entry to the research) against Performance Levels, implemented by the government in association with National Curriculum requirements (1998). Assessed outcomes were subsequently compared with the developmental and linguistic levels made evident in samples of SV utterances, using comparison with target descriptors for Level 1-4.

2.10. Review Question 4 :

Are there any studies that examine the meaningful nature of words or phrases by individuals designated PMLD?

Phase 1, Phase 2 and Phase 3 of the research were designed to explore the acoustic phonetic features of utterances, the intelligibility and the developmental and linguistic levels as shown by the structure and content of participant utterances. Where these

features can be positively evidenced, outcomes imply that participant utterances are meaningful. However, specific demonstration of the meaningful nature of utterances could offer detailed confirmation.

In order to demonstrated that participants used utterances intentionally to convey meaning, Phase 4 was constructed to gather data from semi structured interviews that attributed linguistic meaning to the communicative efforts of the research participants. For the purposes of this study, the definition of 'meaningful' is as follows::

- significant, important, relevant, valid, purposeful. (Oxford Dictionary, 2008)
- contextually appropriate
- using abstract concepts including views, opinions and ideas

The understanding that individuals designated PMLD can communicate with intentional meaning in this way is contradicted by current theories and practice that suggest the opposite.

As noted above, as with other areas of the literature review, it was not possible to identify any studies including participants designated PMLD who use SV utterances. Consequently, the meaningful nature of SV utterances appears to be absent from the corpus and not available for consideration. Efforts to search databases for studies related to PMLD and self advocacy (using varied keywords) were problematic although 'intellectual disabilities' drew more results but included participants with verbal or symbolic language currently not attributed to PMLD individuals.

Due to the absence of studies where the use of SV utterances was included, the literature search examined studies into the capacity of people designated PMLD to use communication meaningfully, via other strategies. Currently, the on-going debate about the ability of individuals designated PMLD to contribute meaningfully to decisions about their own lives has prompted research into their capacity to do so, illuminating the associated issues that reflect the doubts that they are able to communicate meaningfully in any sphere. Consequently, 31 studies were identified, to contribute to consideration of Literature Research Question 4. The collated results identified the present understanding of the extreme difficulties for PMLD people in communicating meaningfully, including 5 studies that focussed on the pre-verbal and pre-linguistic limitations ascribed to people designated PMLD. A further 7 studies focussed on the difficulties in implementing research studies in this area due to the legal and ethical requirements with regard to informed consent. The review also identified studies into different strategies for enabling PMLD people to contribute, despite the perceived limitations reported in the literature.

2.10.1. Pre-linguistic levels

In the first instance, studies into the ability of PMLD individuals to contribute to issues relevant to their own lives addressed the difficulties for participants in communicating beyond pre-linguistic levels. As discussed earlier, the understanding that people designated PMLD are pre-linguistic (Goldbart and Caton, 2010) and are unable to use a range of alternative communication systems as a consequence of their physical and sensory impairments has long been recognized (Beukelman and Mirenda, 2005., Issaacson and Quist, 2011., York and Fabrikant, 2011). Goodwin (2008) acknowledges the use of total communication (where a variety of modes of

communication are used to meet the child's individual needs) and recognises the difficulties associated with communicating with individuals who are understood to be pre-intentional (unaware of the function of communication) as well as pre-linguistic. Bellamy et al (2010) report the idiosyncratic nature of much of the communicative efforts of people designated PMLD , often requiring familiar others to attribute meaning to their efforts. However, the extent to which familiar others can correctly attribute meaning to idiosyncratic efforts by individuals designated PMLD is uncertain (Figg et al, 1996; Porter and Ouvry 2001)

2.10.2. The rights of the child

Despite these acknowledged difficulties, The SEN (Special Educational Needs) Code of Practice (2001) recognised the right of children to contribute to decisions that influence their lives, as stated by the UN International Rights of the Child (Article 12.) The Revised SEN Code of Practice (2015) in conjunction with the Children and Families Act 2014 (Part 3: Children and young people with special educational needs and disabilities), endorsed the principle that children with learning disabilities should be supported in contributing to planning decisions for their present and future needs, but offer little guidance about how to elicit the views, wishes and feelings of children, particularly where there is limited language or no recognizable speech. However, the subsequent requirement in the Revised SEN Code of Practice (2015) to ensure that SEN children should be supported in contributing to planning decisions has required consideration as to how this can be facilitated. The literature review was examined for studies concerned with facilitating meaningful contributions of the views, wishes and ideas of individuals designated PMLD.

2.10.3. Eliciting meaningful contributions

The importance of PMLD people contributing their own views on services and provisions made for them, has been recognized (Clark and Moss 2011., Franklin and Sloper, 2009., Roulstone and McLeod 2011) Ware (2004) reports that increasingly, services meeting the needs of the PMLD population endeavour to represent the views of PMLD individuals, expressed via families and carers where individuals appear to lack a voice of their own. However, efforts to enable people designated PMLD to contribute meaningfully are problematic. Mansell (2010) accepts that PMLD people are often left out of decision making processes because of their complex communication needs. Ware (2004) recognises the difficulties in attributing meaning to PMLD communication, reporting that they cannot either speak for themselves or indicate their own choices when others speak for them, assuming assent to be represented by lack of dissent. Ware (2004) acknowledges that their inability to contribute to decision making on their own behalf can exclude them from a range of pertinent issues about which they should be consulted, yet communication difficulties inhibit such consultation, possibly resulting in their views being ignored. Goldbart and Canton (2010) recommend that communication support should draw on any method that works for the individual, enabling them to express their thoughts, preferences and choices to the best of their ability.

2.10.4. Interpreting views, opinions and ideas

Ware (2004) describes PMLD children as having no point of view as PMLD individuals frequently have no voice in domestic, political or social initiatives that structure their lives. Nevertheless, despite the acknowledged difficulties in enabling individuals to

convey their own views, wishes and feelings, reliance on a communication partner to do so for them has been established but criticism of this approach has been based on the uncertainty of the interpretation. The difficulties in relying on others to attribute or interpret meaning to communication efforts by PMLD individuals been acknowledged(Figg et al, 1996; Porter and Ouvry 2001.) Porter and Ouvry (2001) emphasise the need to validate the communication efforts of PMLD people but note that efforts to attribute meaning by interpreting observed behaviours may not be objective, particularly where the interpretation is by those who have an emotional attachment. Similarly, Figg et al (1996) also demonstrated risks of distortion when those interpreting the child's views are from a different social or cultural background to that of the child.

Pearlman and Michael (2019) in a study to elicit the views of children with special educational needs about their lives at home and school developed an interview questionnaire used in combination with AAC (Augmentative and Alternative Communication devices.) Video recordings of the children's reactions were shown to teachers, Speech and Language Therapists, parents and NHS Psychology staff for their interpretation of the children's responses. It was anticipated that the ratings given by the different viewers would provide valid triangulated results reflecting the adults' interpretation of the children's understanding of the questionnaire and of their views. However, there was no agreement about their views. As a consequence, the study concluded that interpreting responses from those with learning disabilities is not clear cut. There is a need to collect evidence from a wide range of sources to seek corroboration and consensus in interpreting responses from those unable to communicate clearly. Porter et al (2001) stress that the degree of inference as to the

meaning or intention of the individual must be acknowledged and there is the continual need to review such interpretations.

2.10.5. Formulating abstract views, opinions and ideas

Research studies have also addressed issues about the ability or otherwise of individuals designated PMLD to be able to formulate views, opinions and ideas. It has been suggested that the abstract nature of these concepts may be beyond the degree of profound developmental delay attributed to individuals designated PMLD. Ware (2004) considers that where some PMLD individuals will be operating at a pre-intentional level there cannot be an intention to communicate. More significantly, at this level of development, individuals will be unable to formulate a view. Felce (2002) and Cummins (2002) also raise doubts about the ability of people with the degree of intellectual disability attributed to this population to have a view. Similarly, Cea and Fisher (2003) support this observation, reporting that some PMLD people are not able to communicate a choice reflective of their view or opinion. Importantly too, expressing preferences such as choice making activities are set in an immediate present, requiring immediate responses, so that individuals are not required to consider abstract or future events. Thus, choice making responses are not indicative of the ability to form abstract concepts such as opinions and views.

Despite the limitations believed to inhibit choice making activities by people designated PMLD, Goodwin (2008) explores the difficulties in enabling PMLD individuals to make a choice unless supported by a multi-dimensional approach involving others, as suggested by Clarke (2005.) Observing responses to negative and positive

experiences is seen as a potentially valid means to ascertain views. In contrast, Ware (2004) argues that identifying the preferences of an individual is not the same as expressing a view. Studies that demonstrate ways to evaluate enjoyment or otherwise on the part of the individuals designated PMLD, (using video for example) may provide evidence of activities that are consistently enjoyable (or otherwise) to guide how best to discover preferences, but Ware (2004) proposes that people designated PMLD may react to a situation (positively or negatively) but, by the pre-intentional nature of their communication, this is not a communicated choice, preference or view.

Ware (2004) debates what is meant by a 'view' defined by Thesaurus as opinion, viewpoint, belief, conviction, attitude, thinking, idea, feeling, sentiment – and contrasts this with a reaction, which cannot be taken to be expressing a view. Thus, a photo showing the reaction of an individual to an event, cannot be taken to be the same as expressing a view, either positively or negatively. Further, evidence that identifies the individuals likes and dislikes, such as photos and videos demonstrating enjoyment or otherwise, are not necessarily indicative of a 'view,' and care must be taken to avoid interpreting likes and dislikes as such. Nevertheless, due to the difficulties in ascertaining the views of those unable to communicate for themselves, Ware (2004) proposes that the task can be aided with the use of ICT devices and by teaching ways in which choices and preferences can be expressed as much as possible. Alternatively, assessment information indicating developmental levels might better clarify what can be presumed about the individual's views, in preference to methods that rely on a high degree of inference where PMLD individuals are seen as pre-intentional and pre-verbal. Murphy (2004) in an exploration of the ability of PMLD individuals to participant in decision making, concludes that most people designated

PMLD would need a proxy to facilitate the expression of their view about an abstract concept, although proxies may bring their own attitudes and values to the situation, possibly obscuring the real views of those they represent.

2.10.6. Research difficulties

Although there are acknowledged complications in eliciting the views and perspectives of people designated PMLD, the problems are further confounded by difficulties in extending research into this area in order to ascertain how best to do so. Cavet and Sloper (2006) report a lack of research evidence into how this may be achieved. Nind (2013) and Walmsley and Johnson (2003) note problems in gathering valid data from PMLD people and the negative implications for the development of research in this area. Boxall and Ralph (2011) argue for increased research to find ways in which PMLD individuals may be enabled to communicate and express their own views, but recognize the difficulties in designing studies that can be instigated where informed consent is problematic. Cambridge and Forrester-Jones (2003) consider that research studies to elicit the perspectives of people with profound and multiple learning disabilities are few. Increased regulation regarding informed consent effectively excludes their contribution where they are unable to communicate their willingness or refusal to contribute to research. Cluley (2017) proposes that research with PMLD people needs to be mediated to ensure their engagement but recognizes, as does Aldridge (2007) the epistemological difficulties for those with learning disabilities. Accordingly Boxall and Ralph (2011) recommend the use of visual materials as a means to invite PMLD participants to join research studies , including ascertaining their willingness or unwillingness to contribute, presuming their responses

to be meaningful. However, this approach assumes sufficient visual acuity to use such materials, a faculty not available to 13 of the 20 participants in this research and in many individuals designated PMLD. (Garner 2009) reports the commonality of visual impairment in PMLD individuals making access to visually presented test materials problematic.

2.11. Communication interventions

In view of the presumed inability of people designated PMLD to demonstrate the cognitive and social behaviours believed necessary for language to develop and operate, a range of communication interventions have been established, particularly for use in special schools. Such interventions are offered within a framework related to the understanding that people designated PMLD operate at developmental levels integral to infancy. The production of SV utterances by the research participants offers evidence that contrasts with this understanding and has implications for the existing communication approaches offered to them. Therefore, the literature review explored studies into communication interventions to explore the failure of existing approaches to demonstrate the developmental and linguistic abilities made apparent and in contrast to the SV utterances by the research participants.

The literature review identified 6 forms of communication interventions commonly used with individuals designated PMLD, including the research participants.

Dale (2015) proposes that PMLD people can communicate by varied strategies including symbols or by using very simple language in response to appropriate communication interventions. However, the understanding that PMLD people are pre-linguistic and pre-intentional has implications for the use of communication

interventions and their effectiveness. Ware (2004) and Goldbart et al (2014) identified the communication interventions most commonly advocated by Speech and Language Therapists (SaLTs) for individuals designated PMLD.

Ware (2005) recognises two specialist approaches to meeting the communication needs of the PMLD population and cite these as caregiver-infant interactions and those derived from the use of ICT to enable the use of AAC devices. Similarly, Goldbart et al (2014) identified Intensive Interaction as one of two most commonly used interventions provided to PMLD clients by Speech Therapists (SaLTS) and report the established use of this approach to meeting the communication needs of PMLD people. As intensive interaction derives from mother/infant pre-verbal exchanges, this approach sits firmly within the range of communication interventions that view the individual designated PMLD as 'infant like' and the interactive process as 'caregiver-infant' as described by Ware (2004.)

2.11.1. Intensive interaction

Intensive Interaction was pioneered at Springfield School, Leavesden Hospital by the researcher Rosemary Fyfe (1980,), later Rosemary Woods (1985) in conjunction with Ephraim (1979) and Davies (1985) and reported in a series of unpublished studies. That Intensive Interaction was initiated and developed by Ephraim (1979) Fyfe/Woods (1980, 1985) and Davies (1985) is acknowledged by Nind and Hewitt (1988, p.55..)

'Mothering', 'Intensive Interaction Teaching', 'Structured Interaction Teaching' are names given to methods ….pioneered in Springfield School, Leavesden Hospital as a means of promoting the development of language, cognition and sociability in pupils

with the most severe and complex learning difficulties (see Ephraim, 1979; Fyfe (Woods)1980, 1985; Davies, 1985).

The significance of Intensive interaction as a preverbal means of communication was acknowledged and developed at Springfield School where exchanges between the teachers and PMLD pupils were recognised as a joint enterprise, developed 'not in the child's head, or the adult's head but in the interaction between them' Ephraim, 1980, personal communication.

The initial development of Intensive Interaction by Ephraim (1979) Fyfe/Woods (1980) and Davies (1985) was later introduced at nearby Harperbury school and reported by Nind and Hewett (1988). Subsequently, the approach of Intensive Interaction as the basis of communication for pupils designated PMLD has been internationally recognised as a valuable communication intervention, following research and extensive, well received publications.(Hewett, D. and Nind, M.,1988., 1989,1992,1993,2003) and Nind and Hewett ((Nind and Hewett, 1988, 1989, 1994, 2001 2005) that have established this approach in many special schools. Intensive Interaction operates at and within the limited behaviours available to the individual designated PMLD, facilitating pre-linguistic communicative exchanges. A review of the literature demonstrated the process and outcomes of this approach for people designated PMLD.

2.11.2. Research studies in Intensive Interaction.

As acknowledged above, Intensive Interaction was pioneered at Springfield School by Ephraim (1979) Fyfe/Woods (1980) and Davies (1985) and has become a well

established communication intervention in special schools.

Studies into Intensive Interaction have examined this approach with children and adults with a range of learning disabilities, including PMLD, SLD, autism and challenging behaviours. Intensive Interaction replicates the mother/infant dyad to facilitate communication and social responsiveness at the developmental and linguistic level of an infant, presuming this to be the stage at which the individual is operating or the stage towards which the individual will move. (Nind and Hewitt 2005). Thus, the use of Intensive Interaction with PMLD children and adults, including the participants in this study, is based on the understanding that PMLD people are operating communicatively in stages associated with pre-linguistic infancy. Nind and Hewitt (2005) acknowledge that Intensive Interaction makes use of a range of games typically occurring between infants and their primary caregivers, and mirror those used naturalistically by the normal mother and normal infant. As noted above, the development of social and interactive behaviours in infancy are recognized to underpin developing communication, significant for and contributing to later language development.

Firth (2009) contends that there are two aspects of Intensive Interaction integral to consideration of this approach. First is a socially inclusive model (Social Inclusion Process Model.) that is concerned with the development of the sociability of the individual, while the second (the Developmental Process Model) is a process model concerned with the development of communicative skill progression and acquisition. Thus, Intensive Interaction engages participants to facilitate their sociability on one hand, and/ or facilitate the longer term development of communicative skills on the

other. Both may occur , although research studies may emphasis one or other aspect, or both. Behaviours can be both social and communicative – joint focus of attention and reciprocal turn taking in imitative sequences for example, with implications for the immediate situation as well as contributory features for the later and continuing development of social and communicative competencies. Thus, in a review of research studies, there are difficulties in extricating aspects of the interaction that pertain specifically to either one or the other, particularly as Intensive Interaction operates as a process where outcomes are not necessarily specified.

The literature review identified 38 studies where the abstracts identified Intensive Interaction as the focus of the research of which 16 were relevant to this research. For some studies, where terminology made the nature of the participants unclear (severe-profound intellectual disability, severe and complex learning difficulties ,Nind, 1996) the researcher made a judgement about the similarity of the participants to those in this research, using the descriptive data presented to include or exclude studies in the review. Some studies, explored Intensive Interaction in relation to issues that are not relevant to this research (staff training for example) and were excluded on this basis. It was noted too that studies pertaining to individuals for whom Intensive Interaction was offered in respect of autistic or challenging behaviour were not representative of the participants in this research. For the individuals in this research, the very restrictive nature of their physical and sensory impairments mitigates against demonstrations of challenging behaviour so that, even if individuals had issues that might challenge, they are unable to act on them. Moreover, education reports did not identify the presence of such behaviours. Similarly, studies where Intensive Interaction operated as an intervention to facilitate social responses in severely withdraw participants were not representative of the children and young adults in the

research, who are not withdrawn or socially isolated, lacking responses to those around them. On the contrary, despite their very severe sensory and physical impairments, they reflect the social gains resulting from living at home, with the support and benefits of family life. They can and do engage in non verbal interactive sequences readily, possibly reflecting their own early infant experiences from home or in response to experiences offered in educational settings. If these behaviours have positive implications for later language development as suggested (Schaffer,1977; Kaye, 1977; Ephraim, 1979; Fyfe,1980.) they have acquired them. Consequently, although some Intensive Interaction studies focus on individuals who are very withdraw and show very limited signs of social engagement (Lovett, et al, 1996, Nind, 1996) all participants in this study relate readily to those around them, including the researcher. Therefore, although limited in their responses by their impairments, sociability is well established. As a result, the review was particularly concerned with Intensive Interaction as a communication tool (while recognising that elements of sociability and communication are inextricably intertwined in early pre-linguistic interactions) and reviewed studies focussed on the communicative aspect of Intensive Interaction, sometimes including studies where participants were not entirely representative of those in this research.

Nind (1996) used a multiple-baseline design with 6 adults with very limited communication responses. Nind used video evidence of interactions, coding for eight social behaviours: no interactive behaviours, looking at face, happy/smiling face, reciprocal social physical contact, eye contact, joint/focus activity, contingent vocalisation, engaged. Results showed social behaviours previously absent did occur. Nind also measured improved communication behaviours using Kiernan and Reid's

Pre-Verbal Communication Schedule, and a version of Brazelton's Cuddliness Scale. However, participants in Nind's study were institutionalised adults, very different to those contributing to this research, making it difficult to draw parallels. Moreover, Hutchinson and Bodicoat (2015) note that improvements were not always directly concurrent with the beginning of the intervention, so that the relationship could not be ensured although evidence from teachers involved in the study showed that there were no other causative interventions or significant events coexisting with the onset of Intensive Interaction.

Lovett et al (1996) also carried out a research study into the effects of Intensive Interaction on the sociability (rather than the communication) of one pre-verbal adult in a long stay institution and reported an increase in physical contact and increased occurrence in looking behaviour; previously at 10% of the session, raising to 70% on two occasions. During the Intensive Interaction sessions, the participant was also reported to increase his initiation of physical contact; to demonstrate more joint attention, and smile/laugh and vocalise more.

Kellet 2000, used a single case study to report outcomes of Intensive Interaction with a special needs, pre-verbal 5 year old child, initially lacking any symbolic language or formal signs and unresponsive to eye contact or peoples' facial signalling. Kellett (2000) used an AB design and replicated the video coding used by NInd (1996) and reported the positive effects of Intensive Interaction following 10 minute sessions of Intensive Interaction over one year. In addition to video recording, data was recorded on Kiernan and Reid's Pre-Verbal Communication Schedule, and a version of Brazelton's Cuddliness Scale. Recorded outcomes included increases in visual

exploration of the face of the communication partner, increased eye contact, improvements in social physical contact, development of joint focus of attention in interactive sequences, contingent vocalising and an increase in the time spent engaged in social interaction.

Kellet (2003) also examined the efficacy of Intensive Interaction with one boy with severe developmental delay and reported an increase in engagement, measured as an increase in looking at or towards face and joint focus (from average of 8.4% to 48% and 3.7% to 65% respectively). Data was triangulated using the video observations and Kiernan and Reid's Pre-Verbal Communication Schedule, and a version of Brazelton's Cuddliness Scale, as in the previous study (Kellett 2000) However, Kellett (2003) presented variability in coded scores attributed during the period of intervention, limiting the conclusions that could be reliably determined.

Similar studies identified similar results. Samuel et al (2008) employed the same system of video coding used by Nind (1996) and reported small increases in social behaviours(>5%) for four adults with profound and multiple learning disabilities. Although this study was designed to evaluate the responses of staff working with the participants, results for the four adults identified increases in engagement and visual scanning. Barber (2008) in a study with 11 participants, used an AB design, measuring the baseline 12 months before intervention. The study was designed to evaluated changes in the communication behaviour of participants and staff. Videos were coded for 'Indicators of involvement': No interactive behaviours, look at face, smile, socially directed physical contact (SDPC), engagement. For 2 participants, an increase in 'look at face' was recorded and 'increase in smile' for I participant and

increase in SDPC for all participants. Although sociability appeared to increase, the delay between establishing the baseline and the subsequent post intervention measurements makes the relationship less clear. Moreover, Barber (2008) reports data for only 3 of the participants, without explanation for the 8 participants not included, potentially reflecting bias issues. Similarly, Leaning & Watson (2006) reported improvements in only 3 of 5 participants, raising bias issues again.

Argyropoulou & Papoudi (2012) reported increased initiations from the child participant in their ABA methodological design while Zeedyk et al (2009) used an observational, multi-case design to examine levels of social engagement for 10 PMLD adults during their first Intensive Interaction session to measure how quickly an increase in social engagement occurs in an Intensive Interaction sequence. Using micro-analytic techniques for coding video, data was measured for eye gaze, body orientation to partner and proximity to partner. The latter (proximity to partner suggests some degree of ability to move towards or away from the interacting adult, an ability absent in the research participants in this study due to physical and sensory impairments.) Results showed a rapid increase in social engagement for all participants with an increase on at least two measures, while 70% of the sample showed increases on all four measures.

A study by Calveley (2017) typifies the pleasure and benefits as well as the communication outcomes of Intensive Interaction studies where behavioural and severe social withdrawal are not apparent. Calveley engaged in interactive sessions with a 15 year old girl at home who was non-verbal, physically disabled and visually impaired with additional complex health needs. Calveley attributes the interactive

sessions as enabling the child to be a purposeful and successful communicator, motivated to communicate more and identifies communication outcomes for the participant to be;

- More engaged in interactions, and focused on interaction for a longer time: turned towards the person interacting with her.
- Developed greater sense of social connection & was more aware of other's responses.
- Vocalised more frequently, with more intent and expression. Made new sounds, e.g. 'hi.'
- Personality and sense of humour more evident in interactions: more smiles, more facially expressive, seemed happier.
- Responded with pleasure when cheek stroked, and swallowed more often.
- More movement within interactions and improved circulation following interactions.
- More relaxed during and following interactions

Reviews assessing the efficacy of Intensive Interaction stress the need for more research. Firth, (2006) Sharma & Firth, (2012) report research on Intensive Interaction to often be limited to case studies. There are limitations in scope and scale with the studies often being case studies because empirical investigation of Intensive Interaction is challenging to conduct, where emphasis is on process not outcomes. Sharma & Firth (2012) emphasise the need for further methodologically robust research .Goldbart et al adapted Eccles and Mason's (2001) Hierarchy of Evidence and Recommendations Grading Scheme to evaluate the evidence base for Intensive

Interaction as a communication intervention and concluded that Intensive Interaction does not meet Grade A evidence requirements but is accumulating Grade B evidence. Similarly, Hutchinson and Bodicoat (2014) in a systematic review of 15 quantitative and three qualitative papers on the effectiveness of Intensive Interaction on social interaction, self-injurious behaviour and stereotyped behaviours queried the validity of the studies and report limitations in the methodology employed and subsequent implications for the validity of the research. Hutchinson and Brodicoat (2014) consider an evidence base to be lacking and report that conclusions cannot be drawn about the effectiveness of this approach due to the limitations and design of the research studies and the small participant numbers. Berry et al (2014) explore the views of clinical psychologists regarding Intensive Interaction and reported their requirement for a more rigorously scientific approach including theory development allied to clinical testing via case studies. Lewis and Norwich (2005) refer to the problematic nature of evaluating Intensive Interaction due to the emphasis on process, rather than product, thereby negating reference to specific outcomes. Consequently, research evidence for the effectiveness of this approach is, as yet, limited (Caldwell, 2007., Firth, Berry, & Irvine, 2010) . Currently then, the conclusion from much of the above evidence is that this area lacks robust research.

2.11.3. ICT devices for communication

Ware (2005) and Goldbart et al (2015) acknowledge the common use of switches and ICT devices as AAC (alternative and augmentative) communication interventions for children and adults designated PMLD. However, where individuals designated PMLD are also understood to be pre-symbolic (Mansell, 2010) in addition to pre-linguistic, these approaches are not developmentally aligned. Nevertheless, some AAC devices

such as switches, do operate at levels that parallel very early developmental stages. Mansell (2010) refer to the role of switch based approaches to facilitate ‘ cause and effect learning’ where the individual learns that his/her actions on the switch have a consequence. Basic switches are used to develop or maintain cause and effect strategies allied to intentionality, switching on lights or music for example or activating a toy. Goldbart and Caton (2010) cite the role of cause and effect systems to enable PMLD learners to understand that they can make things happen, and can do so intentionally. Their actions have consequences and this facilitates the development of causality and intentionality, concepts contributing to the development of communication.

Lancioni et al (2006a and b) demonstrated the ability of people designated PMLD to learn to use switches to make choices and to attract the attention of relevant others. Singh et al (2003) evaluated the use of switches to make meal time choices, reporting that the single participant learnt and maintained her ability to make meal time choices, albeit in an adapted form to the original intervention. In addition, switch technology can be activated to sound out ‘messages,’ providing an expressive means of communication.

A Big Mack is an example of a communication aid which can function expressively, although programmed by a communication partner and not the individual. It is a simple, one-message communication device, activated at the push of a button which allows a single message of up to 20 seconds to be recorded and played back. Thus, the use of switches with minimal effort does enable the PMLD individual to activate a communicative message prepared for him/her, One or more switches can offer choices by encouraging the PMLD learner to hit the switch that carries the message

chosen on their behalf. Messages are recorded for the individual and placed on a switch. Hitting the switch activates the message. The message will generally refer to something considered relevant to the individual. For example, it may inform parents of activities undertaken by the pupil during the school day or request attention from carers. An advantage of this technology is that the switches are designed to be activated by any working part of the individual. Head switches may accommodate the needs of a severely physically impaired individual, or a Ribbon Switch may be activated by a relatively uncoordinated swipe of the arm by a learner with limited physical control.

The disadvantage of switches is the reliance on staff or carers to select the content of the message (Van Tatenhove, 2005.) The single message 'I did painting today,' placed on a BIGmack switch and requiring only to be pressed, may be tedious in its repetition, but, more significantly, may not convey what the individual needed or wanted to communicate. The vocabulary and the content are the prerogative of the staff or carer recording the message. Messages that alert carers or staff to come to the individual may not specify the reason behind the request, and thus be limited in communicative intent. Thus, even where limited use of IT devices including switches can be facilitated, the vocabulary made available to individuals may be very small due to the options presented. The words chosen are not the prerogative of the user. Van Tatenhove (2005) reports the limitations of AAC systems that are developed to meet 'immediate needs' using nouns primarily for requests. The lack of other grammatical categories (verbs and pronouns for example) in addition to the limited number of nouns made available to the PMLD user, further proscribes and limits the content.

Despite the reliance on others to programme a range of AAC devices, Tai, Blain, & Chau, (2008) report that AAC devices do offer a range of communication methods to meet a spectrum of variable need. The use of switches for developing early causality and intentionality for communication is suggested to be a precursor to the use of high tech AAC devices. A wide variety of assistive technologies have been developed, often activated only by subtle motor movements of the user for control of devices for communication. Millar and Scott (1998) refer to low tech aided AAC that operate without batteries including communication books ,pictures, symbols, and objects for receptive or expressive communication. Depending on physical abilities and limitations, users may indicate the appropriate message with a body part, light pointer, eye-gaze direction, or a head/mouth stick. Alternatively, they may indicate 'Yes' or No' while a communication partner offers (by voice) a range of options. Thus approaches can be adapted to accommodate for visual and hearing impairments but assumes the ability of the individual to recognize and respond to symbolic representations. In this research, the visual limitations of participants impinges on the potential use of symbol systems for comprehension and physical limitations restrict their ability to handle symbolic forms for expressive use. However, where vision is sufficient, eye gaze technology has been trialled for individuals hindered by difficulties with physical abilities.

Eye gaze technology is means of overcoming problems of physical access to communication devices, especially for people who have difficulty with pointing or manipulating materials. Using eye tracking and gaze interaction technology, where the individual visually focusses on a relevant symbol to 'activate' it, offers a means of communication that bypasses problems of physical impairment for the non-verbal

user. Inevitably, this technology is in part dependent upon a degree of visual acuity. Renshaw et al (2011) describe a series of trials to assess the use of an eye tracker as a teaching aid to enable PMLD individuals to develop symbol recognition. The eye tracker provides accurate and relevant information on the eye movements as the individual searches for frequently used symbols or learns to recognize defined symbols. The authors report the ability of the system to facilitate eye tracking as a means of communicating by looking at recognized symbols and provide quantitative evidence of performance improvement. However, as with other communication devices, the vocabulary is not the spontaneous option of the individual and may not convey what he/she intended or wanted.

Notwithstanding the variable methods available for low or high tech AAC devices, research by the University of Sheffield and Barnsley Hospital NHS Trust (Creer et al 2016) estimated the numbers of the population in need of AAC devices to be approximately 0.5% of the UK population or 529 people per hundred thousand population. Users incorporate a wide range of complex and varied conditions, among which PMLD are estimated to represent only a small percentage (2%) as reported by Creer et al (2016) See Appendix X.

The low numbers of people designated PMLD using AAC devices reflect the limitations due to sensory and physical impairments associated with them, even where intentionality can be demonstrated. Many AAC switch devices can be accessed via keyboards, touch screens and switches that require few motor skills of the user, even operating through systems specific to the idiosyncratic needs of the individual such as eye blink switches, head pointers and pressure pads. Nevertheless, researchers and practitioners in AAC systems have long recognized that there is a cohort of individuals

to whom access to such systems is denied due to unintended limitations of the user.

Physical, manipulative and visual skills are frequently pre-requisites to targeted use of switches, screens and keyboards, skills frequently lacking in people designated PMLD and characterized by a range of severe physical and visual impairments. Limited opportunities in their use of, and direct access to, AAC systems for this group has been acknowledged (Isaacson & Quist, 2011; York & Fabrikant, 2011., Beukelman & Mirenda, 2005; Lloyd, Fuller, & Arvidson, 1997.)

An AAC-RERC White paper (2011) notes that a solution to enable access to touch screen interfaces for individuals with both sensory and motor impairments has yet to found. The paper acknowledges concerns about people with language and cognitive limitations and those with motor and sensory impairments. The long established view that individuals designated PMLD are pre-linguistic mitigates against the expectation that they will have the competence to make use of AAC devices, even if they had the physical and sensory means to access them. Beukelman (2012) concurs in the view that many individuals with sensory, motor and perceptual impairments are frequently unable to access communicative devices. The many advantages of AAC technology remain unavailable to a cohort of PMLD individuals with severe physical and sensory disabilities. Wiegand and Patel, (2012) report that, for touch-screen devices, users must lift their finger or hand to select individual icons and avoid selecting multiple icons at once. Because many individuals with severe speech impairments have concomitant limb impairments, repetitive and precise movements can be slow and effortful.

In addition to physical and sensory impairments, cognitive and linguistic limitations are

seen as inhibiting the use of IT devices. Jones, Pring and Grove (2002) stress that progression towards intentional communication is very slow for learners with PMLD and Light and McNaughton (2014) affirm the need for individuals to have, or to acquire, sufficient linguistic and operational skills and knowledge to operate as a competent communicator of an AAC system.

Von Tetzchner and Grove (2003) considered developmental issues in relation to communication and language acquisition in children and propose that for those lacking a pre-existing understanding and knowledge of speech systems, acquisition of a meaning system with an AAC method will require multiple models of language. Thus, it is not only the language used with the child, but the language environment in which others are communicating, immersing the child in experiences modelling pragmatics, syntax and semantics.

Von Tetzchner (1997) reports that a range of communication interventions used with non verbal individuals are different to the communication strategies used by those around them. Thus, in using AAC systems, individuals may experience a discrepancy between the language in their environment and the language used with their communication intervention, where a different form may be utilised. Ballin et al (2011) report that individuals with complex communication needs are typically limited in their access to models representative of effective AAC communication and Porter (2017) reports that for individuals with limited understanding of spoken language, 2 or 3 years of quality receptive language is required prior to their autonomous use of self generated communication with their AAC system.

2.11.4. Research evidence for symbols as

communication

Goldbart and Caton (2010) point out the historically, there has been research into the use of symbols for communication but with little reference to people with profound communication needs. In a review of communication interventions, Goldbart et al (2014) report the use of symbolic systems by Speech and Language Therapists (SaLTS) with PMLD children because, whilst SaLTS acknowledge that people designated PMLD are typically non-verbal, SaLTS propose that they may not be pre-symbolic. Assessment evidence from SaLTS to support this assumption is not presented. Goldbart et al report that SaLTS do offer symbol systems as communication interventions, often where a behavioural association with the symbols is first established to facilitate a subsequent grasp of symbolic concepts. However, although Goldbart and Caton (2010) report the use of symbols in the form of pictures, symbols or photographs even with PMLD individuals who appear to lack representation skills, they also point out the need for good research to investigate the efficacy of these approaches with the PMLD population.

Elks and McLachlan (2007) observe that there are a range of symbol systems used in the UK. They note that symbols may be iconic (looking like the idea represented by the symbol) and can present information simply and visually. Porter (2017) considers that symbols may be advantageous for those with significant cognitive impairments because symbols are visual, static and allow more processing time unlike speech which is auditory, transient and abstract. Elks and McLachlan (2007, p.93) describe the benefits of using visual representations as below:

A picture of symbol can be presented for as long as it takes the user to process the

information and understand it. A word is gone in less than a second.
Pictures or symbols can be very consistent. Words vary depending upon who says it and in what context.
Pictures and symbols require minimal physical skills. Ultimately, they can be linked to switches and computers and thereby made accessible to children.

For participants in this research, symbols as visual representations require visual skills, often lacking in PMLD individuals (Garner, 2009) making access to visually presented test materials problematic yet with known advantages where visual acuity remains.

Goldbart et al (2014) examined communication interventions for PMLD individuals that make use of symbolic approaches, considered to be appropriate to their needs, but reported a dearth of studies specific to PMLD to legitimise this assumption. Beck et al (2009) also report that studies are well documented with adults with moderate or severe learning disabilities but not with children or adults designated PMLD.

However, the use of symbols is demonstrated by PECS (Picture Exchange Communication system (Bondy and Frost LA 1994) developed initially for use with autistic users but subsequently also employed for people with developmental disabilities including PMLD. The non-verbal users are taught to select and offer a picture symbol to a communication partner, thus allowing the user to initiate communication if required. There is the need for learners to be able to demonstrate intentionality; that is to be aware of the need and purpose of communication (Bondy and Frost, 1994) a concept not attributed to PMLD individuals (Coupe O'Kane and

Goldbart, 1998) In addition, users will need to be able to see and handle the picture cards, abilities not commonly evident in the research participants, with additional complexities of physical and sensory impairments inhibiting grasping or holding behaviours and movement towards a communication partner. Where these limitations can be overcome, the expectation is that the use of pictorial symbols will function as an augmentative and alternative aid to facilitate functional communication for non verbal individuals in a social context.

Research into the use of PECS also offers some small but positive outcomes of research into the use of symbolic systems of communication**.** Chambers, et al (2003) compared the effectiveness of PECS with manual signs for teaching mand (request) skills to adults with severe and profound developmental delay where four participants were taught to use both signs and PECS for requests in an alternating treatments design. Three of four participants achieved criterion performance using PECS. and participants were also more likely to request reinforcing items not present using PECS instead of using manual signing. In the Chambers et al (2003) study, it is not clear if participants are characterized by the range of sensory and physical impairments attributed to the participants in this research, where the ability to physically select and pass on picture cards is very limited. In addition, reference to 'severe and profound developmental delay' makes comparison with the profound delay attributed to participants in this research uncertain.

Similarly, Goldbart (2014) report the use of Objects of Reference (Ockelford, 1994) as a commonly used communication intervention advocated by speech therapists for PMLD individuals., although Goldbart et al (2014) note that there is limited evidence

to support the effectiveness of this approach. Ockelford (1994.)) describes Objects of Reference as concrete objects that represent something and have particular meanings associated with them. They are used as a communication aid for individuals with visual or dual sensory impairment and with PMLD pupils. Ockelford proposes that they function as communication, a memory aid and to facilitate understanding for a range of individuals, including those who are both visually impaired and with multiple disabilities and/or learning disabilities. Goldbart et al (2010) identify their use to support and develop communication by signally what will happen next, by facilitating choice and by enabling learners to move from concrete to abstract representations through a hierarchy of meaning. Initially, real objects directly associated with the intended communication are introduced – a cup always used for a drink for example, is used to communicate 'Drink.' Later, the object would have a lesser association with the event or object it represents. Thus, any spoon might be used to represent dinner. As the learner acquires more abstract concepts, symbols or pictorial representations may be utilised. The object 'references' a particular meaning, a shoe to reference a walk for example. As a concrete object, it provides information through touch (and sight for pupils with vision) and can be used to inform the pupil about an activity or event or to enable a pupil to make a request by exchanging an appropriate object with an adult.

Parks (1997) stresses the need for ensuring that objects used in this way meet the learning needs of the individual, acknowledging that the selection of objects used at the earliest stage of development is of considerable importance. For pre-symbolic learners, Parks suggests that a cup used as an object of reference for drinking should be the same cup, used consistently in association with drinking, as this will place

‘lower demands on the learner’ p.112. for whom the gap between non symbolic and symbolic may be wide. This accords with the view that PMLD learners are pre-symbolic (Bellamy et al, 2010., Iacono et al, 2009., Maes et al, 2007) and therefore likely to have difficulties in using symbols communicatively.

Parks (1997) addresses the difficulties associated with the assumed lack of symbolic use in PMLD learners in discussing the separation of labels (words, signs, objects of reference)and those things they are meant to represent. He cautions against the use of objects where it is not obvious that the intended user can recognise the associated between the object and what it is meant to represent, with particular reference to PMLD people. Writer (1987) similarly, recognises that familiar real life objects are best employed initially for the development of communication skills, using objects for conveyance of a message. Pease (1988) et al concur in establishing non symbolic objects of reference as the first stage in the hierarchy of communication by these means.

Research specific to PMLD people into the use of objects of reference is conspicuously limited. A study by Jones et al (2009) investigated the effectiveness of objects of reference as communication aids with PMLD adults by using a standard set of objects with 13 participants over 20 weeks. Results showed significant gains, with a plateau in learning after 10 weeks and greater progress associated with the use of objects at the index level of representation. (Objects are index or indices ‘by virtue of some literal physical participation in the referent object-event’ (Bates et al 1979 p.47). An index is related to the thing it represents because it is integral to, or is a component of, that which it represents. Thus, a shopping bag is an index for shopping, if it is the

bag actually used for the event.)

Objects can also be linked with symbolic systems such as pictures, signs or words to aid and reinforce later learning and use of symbolic systems. However, Goldbart and Caton (2010) in an evaluation of communication approaches used with people with complex needs report the very limited evidential base for the effectiveness of objects of reference as communication and point out the great need for further research into this area.

Goldbart and Caton (2010) point out that historically, there has been research into the use of symbols for communication, but with little reference to people with profound communication needs. However, as described above, PMLD individuals are severely restricted in their opportunities to demonstrate symbolic functioning. The nature and extent of their sensory and physical impairments severely inhibit efforts to demonstrate understanding or to respond with appropriate actions requiring the ability to interact with materials and objects that remain physically inaccessible. Nevertheless, despite the lack of observable evidence of symbolic or linguistic competencies in response to commonly used communication interventions, this study seeks to demonstrate that participants do produce SV meaningful utterances for which their acquisition of symbolic representation must be present for words to be used meaningfully in SV utterances.

2.11.6. Manual signing

Despite the difficulties for people designated PMLD to use words communicatively, signs (British Sign Language and Makaton) have been recognised as a

communication intervention for PMLD individuals. ELKLAN (Language builders for complex needs, 2007) advocate the use of signs because

- Signs can be held still for the user to process the information
- Hands can be moulded to form a sign.
- Signs use skills that a child may already have through the use of natural gesture.

A study by Vandereet et al (2011) monitored the acquisition of expressive vocabulary using speech and manual signs and concluded that the same cognitive, communicative and comprehensive skills are fundamental to speech development and the acquisition of manual signs. This research was carried out with children with intellectual disabilities rather than PMLD but if the same holds true for PMLD people, the acquisition of a signed vocabulary may also be sensitive to the repercussions of the cognitive, communicative and comprehensive delay attributed to them. Thus, although hands can be manipulated to form a sign, the ability of the individual to recognise this as a symbolic representation of the idea he/she intends to convey may not be evident where developmental delay is profound. Moreover, for many PMLD individuals their physical and motor impairments often preclude the use of signing as communication. Certainly, for the participants in this study where hand use is lacking or severely limited due to motor impairments, signing beyond the most basic movement is seldom a viable option.

Although the impairments of PMLD individuals may restrict access to signing as a mode of communication, where it can be offered, the benefits of signing in contributing to communication and speech development has been recognised for many years,

potentially of value in developing linguistic abilities. Powell (1999) building on the work of Reid (1984) reports that signing contributes positively to speech development when learning the sign prior to the word, subsequently used as the same time as speech to support the spoken word. Baumann Leech and Cress (2011) report the improvement in speech of a 'late talker' using sign or picture symbol prompts as an effective means to improve speech production, although the use of signs or symbols did not precede the production of words. Elks (2007) describes the use of Total Communication where signs are used in conjunction with speech so that a core vocabulary of words and signs (used together) can be offered.

2.11.7. Limitations in communication interventions

As discussed above with regard to different communication interventions, different limitations are apparent. However, for the range of communication interventions offered to people designated PMLD, there are some inadequacies that apply generally and require consideration in the use of any communication method offered to the research participants. They are considered below.

2.11.8. Developmentally implications

Martin et al (2010) state that communication difficulties can develop in association with the cognitive limitation of the learning disability. Where such difficulties occur, the need to identify the degree of cognitive limitation has implications for the communication intervention made available. However, as indicated above, in the absence of assessments that can be precisely representative of their abilities, there are significant difficulties in determining the cognitive level or otherwise of the research participants and the appropriate invention required. The presumption that people

designated PMLD are profoundly developmentally delayed may result in communication interventions that reflect their (presumed) profound developmental delay, offering communication interventions that are developmentally inappropriate. For participants in this study, the use of Intensive Interaction as communication operates at levels below those they have attained and are demonstrated by their SV use of language. Equally, for some individuals, interventions may be offered that exceed their developmental level, for example by offering symbols as communication where individuals are truly pre-symbolic. Goldbart et al (2014) report the use of symbols for PMLD learners by Speech Therapists where assessments to justify this approach are not referenced.

2.11.9. Disability implications

As noted above, the range of physical and sensory impairments that typify individuals designated PMLD also impose significant restrictions on their use of a range of interventions. For participants in this study, their physical inability to see, move, reach, hold, point or speak presents major limitations to the options available to them, not withstanding any further consideration of their developmental levels.

2.11.10. Staffing implications

As a result of the disabilities and impairments referred to above, individuals are often unable to access interventions unaided. Interventions are staff intensive, requiring a communication partner to facilitate the efforts of the research participants, showing symbols, presenting auditory options, activating IT devices. Staff training may be required. Forster and Iacono (2008) and Hostyn and Mays (2009) recognize the importance of staff behaviour occurring in response to training in the use of specified

interventions but report that the subsequent nature of their interactions when facilitating communication may not be conducive to improvement.

Similarly, in a study by Chadwick and Jolliffe (2008) where staff were taught a core sign vocabulary, the subsequent failure of staff to use signs regularly was reported. Koski (2010) advocates the need for developing new thinking in conjunction with new approaches so that staff are better able to recognize and support communication interventions.

2.11.11. Environmental implications

As reported above, the communication intervention offered to individuals may be at variance with the environment in which it is intended to operate. The user is not placed in a situation where the same model of communication operates, thereby limiting exposure to and experience of that model of communication (Von Tetzchner, 1997.) Research participants are not placed in classes where manual signing by staff and peers is continuous for example. However, spoken language is the only communication system that operates continually throughout the school/college day, used by staff and verbal peers, offering learning opportunities for language acquisition. The environment is also important in terms of providing an area where communication can function without disruption. Goldbart et al (2014) note the need for changes to the surrounding activities, resources and events to ensure that communication efforts can be enhanced in a suitable setting, without distractions and interruption, irrespective of the nature of the intervention.

2.11.12. Research implications

The decision about the choice of intervention for the individual user is not necessary founded on appropriate evidence based findings. McCurtin and Roddam (2012) summarise research to report that the majority of Speech and Language Therapists (SaLTS) do not consider research evidence in support of their decision in choosing appropriate interventions. The effectiveness or otherwise of the chosen intervention is not evidence based. Goldbart et al (2014) in an investigation into the most commonly used interventions by SaLTS for people designated PMLD also report a lack of information about the influence of research evidence on decisions by therapists, with further research recommended to clarify the effectiveness of interventions and the basis on which they are selected.

2.11.13 User implications

An additional limitation in the use of communication interventions is the difficulties in facilitating contributions by the individual users where their ability to express choices or preferences is uncertain (Cea and Fisher, 2003; Pearlman and Michael, 2019) Problems in accessing the views, opinions and preferences of the intended users are acknowledged (Cummins, 2002., Felce , 2002., Ware, 2004). Although staff, parents and familiar others can be invited to contribute to decisions by professionals, the lack of contribution by the individual user inhibits the extent to which they can themselves express preferences or offer appropriate feedback on the efficacy of the intervention. For the research participants, the ability to access their views and opinions via their SV utterances does enable them to do so, not only commenting on their use of SV utterances but on any interventions made available to them, potentially clarifying what is best suited to them. Participant 1, when asked about education reports that he could

use symbol cards, informed teachers, ‘I can’t really. I can’t see them.’ This enabled staff to provide bigger, clearer versions of the symbols.

Summary

2.12.1. Difficulties with the literature review.

Throughout the literature review, reference to the use of SV utterances by people designated PMLD frequently proved problematic. Currently, as acknowledged above, PMLD individuals are considered to be pre-verbal and pre-linguistic. As a result, search terms that linked PMLD with search terms related to language or utterances were unable to draw relevant results. These are not characteristics attributed to PMLD individuals. The literature search identified a lack of studies into SV utterances by PMLD people, revealing a gap in the corpus and a contrast between present understanding of the linguistic and developmental levels of PMLD people and that of the research participants. Consequently, when this occurred, the review often drew upon studies where research participants differed significantly from those in this study. For example, the design of Phase 2 to investigate intelligibility of SV utterances was planned with references to research studies that explored linguistic and speech competence albeit as disordered or atypical speech and not as sub vocal phonation. Although this inevitably resulted in a mismatch between the children and young adults in this research with those in other identified studies, applicable data was retrieved particularly with regard to tools and methods but not reflective of SV utterances.

2.12.2. Acoustic analysis research

The literature review of research studies into the features of different forms of phonation made clear the methods to be used in the analysis and comparison of SV

utterances with normal speech and whisper. It identified the tools and methods to be employed in the acoustic analysis in Phase 1 of the research. The review also supported the understanding that meaningful language can be present even where it remains sub vocal and operating inaudibly. Although it was not possible to locate any studies specific to sub vocal utterances by PMLD individuals, identifying a gap in the corpus, the data extracted from these studies supported the use of digitally recorded utterances as appropriate, and the use of spectrograms by Praat as good practice. The relationship of participant SV utterances to speech sounds was absent from the literature as was the potential intelligibility of this form of phonation. However, the identification of vowels as significant for speech and whisper and concomitant intelligibility enabled analysis in Phase 1 to focus on this essential element, with further implications for demonstrating the presence of vowels in Phase 2, where intelligibility was explored. The validity of this approach was detailed and widely acknowledged, providing a template for the comparison of SV utterances with normal speech and whispers.

2.12.4. Intelligibility research

Studies that detailed investigations into intelligibility and listener perception contributed to the design and implementation of the intelligibility tests in Phase 2. The structure and content of tests drew upon tools and methods employed for normal, dysarthric and disabled speech and whispers (in the absence of sub vocal studies using PMLD participants.) The varied means employed for assessment of intelligibility enabled consideration of options so that the most appropriate for this research could be evaluated. The use of listener tests using orthographic transcription was selected as a result, enabling a quantitative measure of the number of words understood by

listeners without reference to other variables and with numerical outcomes that could be analysed statistically.

2.12.5. Research into developmental levels of individuals designated PMLD

Without exception, the literature was unequivocal in placing people designated PMLD within the developmental stages of infancy. The review made clear that the grasp of intentionality and object permanence, seen as necessary pre-requisites for language, is assumed to be absent in individuals designated PMLD (Vlaskamp (2005). While limited literature supported the possibility that assessment procedures underestimated competence in this population (IASSID, 2016) definitive research to prove the case was absent. This major omission offered the opportunity for the research to provide evidence of assessed developmental and linguistic levels in SV utterances above 0-24 months, as undertaken in Phase 3 of the study.

2.12.6. Research into meaningful SV utterances

The research hypothesis proposes that the SV utterances produced by the 20 research participants comprise meaningful as well as intelligible language. The literature review made evident that current theories and research contrast with evidence of meaningful SV utterances by the research participants. Instead, studies recognise PMLD individuals as people who lack language due to their pre-linguistic status. Additionally, they are pre-intentional and cannot communicate intentionally. Further, they lack the ability to use meaningful language due to the profound nature of their developmental delay. Currently, it is accepted that they cannot formulate meaningful abstract concepts such as views, opinions and ideas. Phase 4 was

therefore designed to explore the meaningful nature of their language

- as defined by the Oxford Dictionary (2008) as ‘significant, important, relevant, valid, purposeful.’
- contextually appropriate
- using abstract concepts including views, opinions and ideas

The literature review made clear that evidence from the research participants was needed to demonstrate the meaningful nature of their utterances as identified above and Phase 4 was therefore specifically designed to do so, meeting the criteria in each item identified above.

2.12.7. Research into communication interventions

The use of SV utterances as potentially communicative was absent from the literature. The literature review presented currently accepted communication interventions for people designated PMLD and reported research studies examining the effectiveness of the different approaches. Outcomes demonstrated the lack of robust research into the efficacy of communication interventions and the gap in the availability of linguistic communication strategies for children and young adults in this population, where the designation of pre-linguistic applies, suggesting potential advantages in SV phonation as communication for the 20 research participants.

The literature review identified that the existence of SV utterances by people designated PMLD is not recognised, clarifying the aim of the research by making clear the current lack of knowledge and awareness of this phenomenon. In addition,

the use of SV utterances by the research participants emerged as contrary to current understanding of the nature and abilities of this population, currently viewed as pre-linguistic and profoundly developmentally delayed. Assessments to confirm or refute this are considered unfeasible. The research questions arising with regard to SV utterances by individuals designated PMLD were not addressed in the literature.

Consequently, the rationale and justification for the research was evident, identifying SV utterances by the research participants as representing a completely divergent view of the abilities of people designated PMLD and indicating a gap in the literature. The aim of the research was therefore clarified, supporting exploration of the SV utterances by the 20 research participants as original research.

CHAPTER 3 METHODOLOGY

3.1. INTRODUCTION

This chapter explains how the research process was designed. It describes the philosophical tenants underpinning the research methods and presents the methodological justification for the research, explaining the reasoning for the methods used. It explores the strengths and limitations of methodological approaches, using qualitative or quantitative methods, or a mixture of both. It reports the research design.

3.1.1.The hypothesis

The research hypothesis to be tested was developed following the accumulation of data from the literature review, in combination with the experience and knowledge of

the researcher. The literature review established the current understanding that people designated PMLD are pre-linguistic. In contrast, the experience of the researcher and evidence provided by samples of participant recorded SV utterances suggested an alternative understanding. The children and young adults taught by her were linguistic, although non verbal and therefore expressing their utterances sub vocally.

The research testable hypothesis was as follows,

Children and young adults designated PMLD can produce meaningful sub vocal utterances intelligible to listeners.

A testable hypothesis was chosen in order to prove or disprove the hypothesis by:

- Observing an unexplained phenomenon in the form of sub vocal utterances by PMLD individuals believed to be pre-linguistic.
- Creating a testable hypothesis
- Testing the hypothesis by data collection
- Drawing conclusions following the analysis of collected data

In gathering data and processing information the researcher applied prevailing and accepted standards reflected in the major precepts of all scientific disciplines as verifiability, predictability, falsifiability, and fairness. They are addressed below:

3.1.2. Verifiability

In order to ensure verifiability, inclusion of the steps taken to test the data accumulated in the four phases are reported. In Phase 1, concerned with acoustic analysis, Praat a recognized instrument is adopted, available for on-going analysis of the SV samples and replication of the procedures described. Details of how to record SV utterances by individuals designated PMLD are reported, available to be replicated. The tests used to assess listener intelligibility are similarly detailed and described, both method and content, and the specifics of the tests used to establish the linguistic and developmental levels of the participants are also defined. Thus, in Phase 2, statistically significant data was reported in association with measured outcomes of intelligibility tests used to determine the probability of a hypothesis being true or false.

For Phase 3, triangulated results of three assessments supported the outcomes where linguistic and developmental were assessed by the researcher. Subsequently, three moderators also assessed the developmental and linguistic levels of the recorded samples, also confirming the intelligibility of the audio samples used in that phase. In Phase 4, where participants were invited to demonstrate the meaningful nature of their utterances by contributing their views, opinions, and ideas the semi structured interviews with participants were recorded with audio samples included and retained as testable evidence of participant responses. Finally, the inclusion of audio samples throughout the study attest to the authenticity of the data upon which the research relies.

3.1.3. Predictability

Predictability enables predictions arising from the theory underpinning the research to be made about future events and is a measure of the strength of the theory.

However, this study does not draw on or propose any specific theory related to SV utterances and future events. Nevertheless, the outcomes of the investigations described in the four phases of the research may contribute to subsequent research to examine SV utterances by people designated PMLD with the potential for theoretic explanations and predictions. The evidence of the production of SV utterances by the research participants in this study may be related to theories of language acqusition, an area for further research.

3.1.4. Falsifiability

Falsifiability refers to whether a hypothesis can disproved. Despite demonstrations of SV utterances by the research participants in this research, it is entirely feasible to undertake observations or experiments to test the hypothesis by inviting the participants or other people designated PMLD to record further samples. In addition, as the methods of gathering audio data are detailed thorough the study, all elements can be replicated as a means to prove or disprove the hypothesis.

3.1.5. Fairness

Fairness implies that all data must be considered when evaluating a hypothesis so that the researcher is not selective in data to prove or disprove the hypothesis. Fairness is maintained in this study where the positive and negative outcomes in each phase is reported. The spectrographic samples of SV utterances in Phase 1 report the positive and negative results of Praat analysis of acoustic phonetic features in utterances. The outcomes of listener intelligibility tests presented in Phase 2 detail the correct and incorrect responses of listeners. The audio samples in Phase 3 align

with recognised assessments, without outcomes reported for all participants. In Phase 4, although the content of audio samples in Phase 4 are transcribed by the researcher audio samples are presented and make clear participant responses that can be authenticated by the participants and their teachers and parents.

3.2. Research strategy

An appropriate research strategy was sought to described and investigate different elements of SV utterances to collect a range of data, to ensure breadth of study yet within a narrow focus on this previously unrecognised phenomenon . As this had not been previously investigated, the research needed to make certain that the research strategy met the fundamental and essential criteria that enables outcomes to be recognized as justified and valid. Consequently, the research was planned and organised as detailed below.

3.3. Rationale for the research design

The research design followed from the need to describe the phenomenon of SV utterances and test the hypothesis by exploring the characteristics of SV phonation and the language produced in this form, currently unreported in people designated PMLD. The research was undertaken using four research questions derived from the hypothesis, exploring and describing four different elements of SV utterances. The hypothesis was advanced due to the researcher's awareness of SV utterances produced by an individual designated PMLD. His linguistic competence was made evident in samples recorded as dysarthric audible vocalisations, where 'silent' gaps between vocalisations were subsequently amplified to reveal sub vocal, meaningful, linguistic utterances. Such utterances are presumed to be conspicuously absent in,

and contrary to the limited expectations of the linguistic behaviours of an individual designated PMLD. In addition, amplified play back of the original recordings appeared to be not only meaningful to the researcher, but also intelligible to parents and familiar others. This unexpected outcome suggested the possibility that other individuals, similarly designated PMLD, might be able to produce meaningful SV utterances, intelligible to listeners. In order to investigate this possibility, the research was designed to explore the existence and use SV utterances by focusing on different but interlinked elements to provide a full, in depth account of this form of phonation. The intention was to provide and describe the phenomenon of sub vocal phonation used by 20 research participants designated PMLD, while presenting a range of variables synthesised as data to substantiate the hypotheses.

3.3.1. The four phases

In order to test the hypothesis, the research was designed as a study with four separate phases, each addressing one of the four research questions derived from the hypothesis as follows:

How do SV utterances compare phonetically with normative samples where instrumental analysis allows comparison of the acoustic phonetic features?

Are the participant SV utterances intelligible such that familiar and naïve listeners would be able to understand the amplified samples?

Do participant SV utterances demonstrate linguistic and cognitive levels beyond the developmental age of 0-24 months commonly attributed to individuals designated PMLD?

Are the SV utterances produced by the 20 research participants meaningful?

The four phases were therefore constructed as follows:

3.3.2. Phase 1

Research question 1

- How do the SV utterances by individuals designated PMLD compare phonetically with normative samples where instrumental analysis allows comparison of the acoustic phonetic features?

This question was concerned with the extent to which the recorded acoustic performance by participants could be designated as 'speech like' words and not simply 'noise.' Consequently, instrumental analysis of the utterances was required to identify the presence of acoustic phonetic features known to be present in normal speech and whispers so that utterances were comparable with them. Phase 1 addressed this with the identification of an instrumental tool for analysis of the acoustic phonetic features of SV utterances in comparison with normative speech and whispers.

3.3.3. Phase 2

Research question 2

- Are the participant SV utterances intelligible such that familiar and naïve listeners would be able to understand the amplified samples?

The second phase of the research was concerned with the intelligibility of the SV

utterances . The researcher and familiar others had found the original samples produced by Participant 1 to be intelligible but this had not been tested further, either for Participant 1 or the 19 others who joined the research subsequently. The researcher considered intelligibility to be a crucial element for listener perception of the utterances as meaningful language , both to establish the degree to which real words were present and understood as such, and as evidence of the developmental and linguistic levels of utterances. Intelligibility too, contributed to the proposal that the utterances contained the features of real words, as postulated in Research Question 1. Phase 2 therefore addressed the research question with an examination of the listener intelligibility of SV utterances in closed and open conditions by inviting 40 listeners to assess SV utterances in 7 closed tests and 3 open tests

3.3.4. Phase 3

Research question 3 was addressed in Phase 3 of the study.

Research question 3

- How sophisticated is the language used in utterances? Does it demonstrate linguistic and cognitive levels beyond the developmental age of 0-24 months commonly attributed to PMLD individuals

- The level at which utterances operated linguistically and developmentally was an important consideration. The expectation that PMLD individuals operate at levels comparable with infancy (0-24 months) and are therefore pre-linguistic and developmentally delayed is contrary to the demonstrated performance of

language skills as shown in participant SV utterances. Consequently, in order to assess if participants were operating developmentally and linguistically beyond infancy, Phase 3 was designed to measure the linguistic and developmental levels demonstrated by the content and structure of participant utterances using 3 assessment measures:

National Curriculum Performance Scales and Early Years Foundation Stages.(Gov.UK Department of Education and Standards and Testing Agency.)

Milestones: Developmental stages in language acquisition (National Institute on Deafness and Other Communication Disorders (2000) Speech and Language Developmental Milestones. National Institute of Health (NIH) Publication No. 00-47)

- Mean length of utterance (Brown, 1973).

3.3.5. Phase 4

Research Question 4 was addressed by Phase 4 of the study.

Research Question 4:

- Are the SV utterances produced by the 20 research participants meaningful?

For this study, ‘meaningful’ was

- as defined by the Oxford Dictionary (2008) as ‘significant, important, relevant, valid, purposeful.’
- contextually appropriate
- using abstract concepts including views, opinions and ideas

The ‘meaningful’ nature of utterances occurs in association with the extent to which they are relevant and appropriate to the context in which they arise. If this were not the case, utterances could be intelligible yet not meaningful. Moreover, ‘meaningful’ reflects the current debate (Ware, 2004) about the ability of PMLD individuals to formulate and express abstract concepts such as views, opinions and ideas, competencies considered to be lacking in this population . They are considered to lack the ability to respond meaningfully due to their pre-linguistic status and their inability to formulate concepts in association with their profound developmental delay. Phase 4 was therefore designed as a series of semi structured interviews to elicit ‘meaningful’ responses that were relevant and appropriate and demonstrative of the formulation of expressed concepts including abstractions such as ideas, opinions and views.

An additional benefit of the use of semi structured interviews in Phase 4 of the research is the inclusion of participant contributions as qualitative data. Quantitative studies have been criticized for their failure to reflect the views and opinions of the research participants, best placed to comment on the research and who might usefully contribute to the hypothesis under consideration. The failure to undertake studies inclusive of PMLD people has also been censured (Boxall and Ralph, 2009) For individuals designated PMLD, where their perceptions and understandings have been

made inaccessible by their limited abilities to communicate, opportunities for their contribution is seen by the researcher as invaluable.

3.4. The research paradigm

While recognizing that she was not detached from the issues being studied , the researcher sought a methodological design in alignment with a paradigm within which her research approach could operate coherently. Methodology refers to the strategy or design of the research, defining how the study should be undertaken and guiding decisions about the type of data required and the most suitable data collection tools. Such methodological questions require the researcher to consider the research paradigm, encompassing the research approach, strategy and philosophy and defined by Johnson and Christensen (2004) as a perspective that is based on the set of distinctive and credible shared assumptions, values, concepts and practices. The paradigm reflects the researchers basic belief system and theoretical framework, and encompasses the researchers ontological position, reflecting 'the nature of our beliefs about reality' (Richards, 2003, p. 33). A conception of reality as a subjective social construct vies with a conception of reality as an objective reality, independent of the individual or society in which it arises. Patton (2002) summarizes the dichotomy between 'A singular, verifiable reality and truth [or] socially constructed multiple realities' (Patton, 2002, p. 134) that must be addressed. Therefore, if a singular verifiable truth is assumed, "then the posture of the knower must be one of objective detachment or value freedom in order to be able to discover 'how things really are' and 'how things really work'" (Guba & Lincoln, 1994, p. 108). However, the resultant study may be isolated from reality, occurring without reference to the social world inhabited by the research participants. If knowledge is composed of socially constructed

multiple realities, knowledge and reality cannot be constructed separately to individual perceptions or those of others. From this viewpoint, the researcher must reject the concept of people as objects of natural science and instead relate to and engage with them in efforts to understand the social and individual context of the phenomena under review. Differences in how these aspects of research are viewed and explored by researchers reflect differences in "their perception of how the knowledge can be created and constructed in a rigorous and meaningful way in order to answer a research problem." (Altinay and Paraskevas 2008:69).

3.4.1. Quantitative research

Quantitative research is conceptually concerned with measurable facts, assuming a fixed reality where data can be analysed numerically and statistically and is not open to ambiguity in interpretation (Antonius 2003). Validity and reliability are measurable. Robson (2002) acknowledges that quantitative methods expedites data standardization with large amounts of data, better facilitating the organization and management of the data. Robson (2002) also recognizes the advantages of data standardization achieved by quantitative methods, where findings can be validated by measured outcomes. Researcher objectivity can be maintained and results produced that are rational and scientifically objective (Denscombe, 2010) Results can be aligned with a theoretical perspective, empirically proving or disproving the theory by identifying patterns and relationships within and between data sets. Discreet variables can be controlled for. However, quantitative studies have been criticized for their failure to reflect or include participant involvement in the study, where their views, opinions and ideas might usefully contribute to the hypothesis under consideration. The world inhabited by the research participants.

The advantages of paradigm that views knowledge as a fixed and scientific reality underpinned those phases of this research where measurable outcomes validated the knowledge. Analysis of acoustic phonetic features in Phase 1 relate to scientific laws that underpin sound and its features. Quantifiable measures of listener intelligibility in Phase 2, in conjunction with quantifiable measures of developmental and linguistics levels in Phase 3 provided replicable, objective evidence of participants abilities. Such quantitative evidence, unaffected by subjective perspective of either the participants or the researcher, occurs within the construct of scientific enquiry to reflect the positivist/empiricist stance that advocates the use of deductive reasoning in theory or hypothesis-driven investigation. It results from the standpoint that the purpose of research is to identify laws that underpin knowledge and objective reality, constructed and governed by those laws. In demonstrating abilities not previously accessible to test measures, due to the absence of the means to conduct such tests for PMLD individuals, the research could provide data constructed in a numerical and objective manner integral to the view of knowledge as a fixed reality. Where measures of listener intelligibility and the linguistic and developmental levels of participants have been previously inaccessible, and therefore not subject to evaluation, both features could be demonstrated and objectively presented such that the value of a scientific perspective for this element of the research was significant.

3.4.2. Qualitative approaches

A contrasting reality reflected in qualitative research encompasses a constructivist/phenomenological approach that facilitates a subjective individual account of reality derived from data that provides the basis of inductive reasoning to

generate a new theoretical perspective (Guba and Lincoln, 2005). Although there are benefits to this research in adhering to quantitative methods that can be seen as objective, quantitative studies have been criticized for their failure to reflect or include participant involvement in the study, where their views, opinions and ideas might usefully contribute to the hypothesis under consideration, but without fixed, measurable data to substantiate them. The inclusion of the 20 PMLD participants in this study refutes the criticism, recognising that the involvement of research participants in research studies has been acknowledged (Wertz et al. 2011.) facilitating measurable outcomes in the quantitative phases of the study in to support the qualitative methodology in Phase 4. Moreover, opportunities for the participants to contribute is seen by the researcher as invaluable, emphasising development of their life skills as well as their language and communication skills.

Palys (1997) has proposed that the advantage of the use of qualitative methods is vested in the inherent flexibility of an approach that can encompass a range of unexpected data or evolving themes. Unlike quantitative data collection, qualitative procedures allow for further exploration of unintended directions and trends, pertinent to objectives but previously unrecognized. It operates as a process rather than a goal, enabling examination of contributory issues and features that have the potential to be meaningful. Palys (1997) refers to the researcher engaging a phenomenon of interest and the need to let theory emerge from the data. This view acknowledges the complexity of social experiences, such that the researcher cannot know the extent of data to explore and unforeseen issues may arise. In the case of PMLD participants, where their own perceptions of their lives and their knowledge has not been reported, the ability to pursue unexpected trends has obvious benefits as previously

unattainable features of their perceptions may be revealed.

A qualitative approach, advocated by Carl Rogers (1951) explores human behaviour from the perspective of the people concerned, collecting information from participants through observation and interviews. Themes emerge, to be analysed and recorded in the language of the participants themselves. This requires an interpretative and naturalistic stance to explore social reality via the understandings of those involved. Analysis of data is achieved following recognized, structured techniques, including Grounded Theory (Glaser and Strauss, 1967) Grounded theory provides systematic guidelines for collecting and organizing information in order to generate theories based on meticulous analysis of empirical data. It includes ongoing coding of data and categories, cross referencing information obtained and analytical exploration throughout the research in order to develop an explanatory theory derived from concrete facts. It places qualitative research within a structured and rational framework. However, despite structured analysis, qualitative designs can be criticized for the subjective nature of data, where precise standards of reliability and validity are not numerically measurable and the researcher's interpretation reflects her entry into the participants' world, where she cannot help but be affected by it. The end result is an interpretive account, not an exact picture. (Charmaz 2006)

3.4.3. Descriptive research

Due to the apparent absence of the unknown phenomenon of SV utterances from the corpus, SV utterances by people designated PMLD have not been investigated. Consequently, elements of the research needed to include descriptive accounts of the occurrence, particularly with reference to the acoustic production of SV utterances.

The research needed to describe and focus appropriately on the characteristics of SV phonation that remain currently unreported. Consequently, features pertaining to SV utterances required clear identification and description in support of the hypothesis that they are meaningful and linguistic. In examining research designs, consideration was given to those that encompass descriptive accounts of phenomenon.

Irwin et al (2008) identify descriptive research as that used to describe 'naturally occurring phenomena' (Polit and Hungler,1999) during which selected variables are observed and reported (Hegde 2003) A descriptive research approach also allowed for observation and reporting of the characteristics of the phenomenon of SV utterances, currently unreported in the literature and potentially available as a pre-cursor to future research and investigation. Additionally, in descriptive research, the methods for data collection and analysis are not limited, encompassing multifaceted approaches to enable the researcher to move between methods that best suit the purpose of the research. Thus, a descriptive approach integrates readily into a mixed methods design, including as it does the freedom to draw on qualitative or quantitative techniques.

3.4.4. The limitations of descriptive research

There are some limitations in the use of descriptive research that must be considered. Noticeably, researcher bias may lead to subjectivity in the choice of data to record and to include in the findings. It is important therefore, to ensure objective observation and recording of information. Thus, an important consideration was the need to describe precisely the characteristics and features of SV phonation by participants, neither adding nor subtracting from the measurable and observable elements integral to it.

However, because descriptive research does not manipulate variables for statistical analysis or correlate variables to examine cause and effect, it can be viewed as unscientific as a result. In this study, the use of quantitative methods in Phase 1, Phase 2 and Phase 3 reported instrumental measures to supplement quantitative and descriptive elements in order to provide a scientific foundation. Thus, although a descriptive approach may be criticized for the difficulties in replicating the research, the process of acquiring and presenting data by digital recording of sub vocal phonation is reported, thereby providing an instrumental means by which this process can be repeated, described, analysed and explored by others. The study also provides measurable and observable data on the features described as integral to SV phonation, within a framework already recognized and acknowledged in explanations of normative speech. Computer programmes were used (Praat) for the acoustic phonetic analysis of sound samples and listener tests provided measurable data on the intelligibility of SV utterances.

Following consideration of different paradigms, the researcher recognised that a belief in the exclusive nature of one paradigm in comparison with another results in a narrow focus on a particular philosophical or methodological approach that constrains opportunities for wider and richer investigation. Instead, by going beyond the parameters associated with a pre-determined paradigm, exploration of the phenomena under review can employ method, tools and philosophies that offer the 'best fit' in achieving outcomes that deliver new knowledge and understandings.

3.4.5. Ontological, cosmological and epistemological beliefs

The development of the research strategy arises from assumptions about the creation of knowledge and therefore influences the research strategy. Thus, the researcher must acknowledge her own ontological and epistemological assumptions in order that the research can be meaningful to others, enabling them to view the outcomes in alignment with the theoretical underpinnings and terminology of the paradigm to which she adheres.

The researcher conceived ontological, cosmological and epistemological beliefs to be interrelated, each influencing the other and each contributing to what is understood to be true in knowledge creation. Following, the researcher's ontological position did not conceive reality to be either a subjective or objective creation, but rather an amalgamation of both. In seeking to view these assumptions as integrated, the researcher accepts herself and others as multiple identities, defined by different views in different contexts, rather than one single objective definition of 'self.' Knowledge can therefore be in part subjectively created yet within a milieu that can be objectively constructed. Although the recognition of an objective reality based on immutable laws argues for a scientific reality that can be precisely measured and determined, other realities can also exist. A subjective reality can be integrated with objective detachment where appropriate, specific to areas of the research that call upon, indeed require measurable facts. The investigations into listener intelligibility and into the measurable levels of participant developmental and linguistic levels epitomise this requirement. Noticeably in this research, the exploration of the acoustic phonetic features of SV utterances planned for Phase 1 of the study blends different perspectives in relation to intelligibility, explored in Phase 2. Intelligibility sits at the boundary of a physical entity that is speech but where the listener's response is not a

fixed interpretative expression of truth.

According to Bryman & Bell (2013) an epistemological issue concerns the question of what is (or should be) regarded as acceptable knowledge in a discipline. In considering the domain of epistemology as a theory of knowledge, the researcher accepted that the scope and methods of distinguishing facts related to the research questions will reflect her own individual epistemology. Her own role is to be that of a researcher seeking to enhance understanding or extend knowledge through the research, acknowledging that adherence to an ontological belief system has influenced her own epistemological assumptions. Her fundamental position concerning the nature of reality in relation to the research questions was integral to decisions concerning the trustworthiness or validity of data, reflected in her epistemology and based on her own construction of reality and her own experiences.

Where paradigms place boundaries on knowledge, including and excluding what is considered valid, the researcher sought a wider epistemological perspective to reflect her ontological values. Thus, the researcher acknowledged and accepted the legitimacy of views that defined knowledge and the acquisition of some forms of knowledge in differing ways, but found it insufficient and illogical to assume that knowledge could itself be detached and restricted by limitations that are theoretical and abstract. In seeking a wider epistemological perspective, the researcher believed that research should be seeking knowledge both objectively or subjectively derived. As a result, she believed that research relates to both the acquisition of quantifiable knowledge but that, for this study, perceptions, opinions, views and experiences of those on whom the research is focused cannot be excluded. Within the educational

context , the research participants are viewed as lacking understanding beyond that of infants, unable to take a meaningful place in society that is not mediated by others who represent them, often without their own contribution to that representation. Their 'knowledge' is not included or credited. In contrast, by inviting and facilitated participant individual contributions to this research, their (unexpected) knowledge is a major element of the investigation, through which their involvement interjects valid knowledge arising specifically and individually from their conditions and their experiences. The participants' experiences cannot therefore be replicated or truly experienced by others. It is their truth despite and not because of how they are viewed. For this reason, participants have made their own contributions to this study, defining themselves by explanations rooted in their own subjective experiences. Although the researcher is aware that she is the mediator for their contributions, efforts to ensure the integrity of the research relies as much on the right of participants to contribute as does the quantifiable outcomes resulting from the investigation into listener intelligibility and measures of developmental and linguistic abilities of the children and young adults. Efforts to re-conceptualize the role of people designated PMLD in our society can facilitate the emergence of a group currently excluded and powerless. Outcomes of knowledge creation both rationally derived and subjectively perceived provided evidence of abilities demonstrated within contexts that can be acknowledged educationally, contributing to a wider and fuller understanding of the participants and their needs.

In considering the cosmological assumptions that underpin the research, the researcher recognizes a world view of the universe as an interconnected , holistic entity where all aspects of human life arise from and operate within a social world in

which people exist. Thus, the 'self' co-exists with all humanity and individually with those around us, extended by the global perspective now available via modern technology that brings the global world directly to individuals. Individuals are formed in relationship with others and not independently of them. Knowledge arises though participation and involvement with others, accepting that there are differences in understanding that are themselves integral to 'knowledge.' Knowledge and learning therefore evolve in concurrence with real life, and across time. Her cosmological perspective has influenced her ontological perspective and her epistemological understanding, providing the foundations for the methodological design applied in this study where the researcher considered that a rigid adherence to one paradigm or another limits and restricts investigations but that can draw instead on different elements of different paradigms.

Thus, in reflecting upon her own cosmological, ontological and epistemological stance, the researcher nevertheless recognized that the extreme positioning of different paradigms presents an epistemological problem where knowledge arising from either a quantitative and qualitative research paradigm is viewed as incompatible**,** each with the other. This leads to the assumption that research cannot make parallel or simultaneous use of positivist and constructivist stances to produce meaningful outcomes (Guba and Lincoln, 2005). As indicated above, the view arises that the positivist/empiricist stance reflected in quantitative research and the constructivist/phenomenological approach acknowledged in qualitative research are incompatible.

Moreover, a belief in the exclusive nature of one paradigm in comparison with another

requires a narrow focus on a particular philosophical or methodological approach that constrains opportunities for wider and richer investigation, going beyond the parameters associated with a pre-determined paradigm. Instead, exploration of the phenomena under review can employ methods, tools and philosophies that can be precisely measured and determined while still accepting that other realities can also exist. A subjective reality can be integrated with objective detachment where this was appropriate, offering the 'best fit' in achieving outcomes that deliver new knowledge and understandings.

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3.4.6. Mixed methods

Despite the apparent incompatibility of qualitative and quantitative paradigms debated by researchers, Morse (2003) proposes a parallel approach, acknowledging the distinct nature of the underlying philosophy of each method, yet enabling each to reflect the strengths specific to them and recognizing the advantages in the combined use of both qualitative and quantitative approaches. Hardy & Bryman, (2004) have advocated the combined use of both approaches in order to recognize and take advantage of the similarities in qualitative and quantitative approaches. Onwuegbuzie & Leech (2005) acknowledge that a mixed methods approach contrasts with research paradigms that emphasise either qualitative or quantitative methodologies, but recognize the use of both methodologies within the same study. Johnson et al. (2007) endorse this view, also recognizing a mixed methods approach as the third major research paradigm. Denscombe (2008) too proposes that mixed methods has been acknowledged as a third paradigm for social research, offering a viable alternative to the use of either qualitative or quantitative frameworks by the joint use of both This

understanding has been supported by Cameron & Miller (2007) encouraging consideration of paradigms that are not specifically associated with only qualitative or quantitative research, but instead seeking association with philosophies and world views that can encompass all of quantitative and qualitative research..

3.4.7. Implementing a mixed method approach

Consideration of the advantages of qualitative and quantitative methodologies identified the use of a mixed methods approach for this research as advantageous, facilitating different means to explore different aspects of the phenomenon under investigation. Both qualitative and quantitative methods offered varied yet appropriate instruments to achieve the research aims and objectives. Thus, in this research, the use of a mixed methods approach was selected and implemented without conflict, while adhering to the principles of quantitative and qualitative research in the design and implementation of each. Johnson and Onwuegbuzie (2004) acknowledge that this approach enables researchers to employ a methodological mix better suited to answering many of their research questions. The combination of qualitative and quantitative approaches to data collection and analysis mirrors that advocated by Greene et al (1989) who recommend that each part of a mixed methods study should complement and support the other. . Therefore, a complementary study requires that consideration be given to the extent to which methods differ for different aspects of the research , and the degree to which the phenomena investigated by each method are similar or different. Greene et al (1989) propose that, despite differences in methods used, the investigation should examine different aspects of the same phenomenon, giving equal weight to different parts of the study and collecting data concurrently. This approach has applied to this investigation, where examination of acoustic, linguistic,

social and communicative aspects of sub vocal phonation have been of equal significance and investigated in parallel, not consecutively. Quantitative analysis of objective data has been conducted in conjunction with examination of qualitative data that reflect the human experience of the participants in this research. Different aspects of sub vocal phonation were explored quantitatively and qualitatively to bring related elements together to produce a resultant synergy.

The facility offered by a mixed methods approach to carry out data analysis and integration throughout the study, as reported by Creswell et al. (2003) and Onwuegbuzie and Teddlie (2003), was seen as advantageous where the use of mixed methods enabled examination of the extent to which the quantitative and qualitative results converge. Qualitative data could help to explain the quantitative methods and vice versa. As noted above, Morse (2003) Johnson et al (2007) and Cameron and Miller (2007) acknowledge the advantages in the use of both qualitative and quantitative approaches within a mixed method framework, allowing different data types to be jointly co-opted to generate meaning.

3.4.8. Pragmatism

Goldkuhn (2012) points out that pragmatism operates in a pluralist manner using combinations of methods that work relative to the research purpose. Morgan (2007) advocates mixed methods within a conceptual framework of pragmatism where different approaches can be combined and writes of ‘inspiring others about the practical value of research designs that combine different methods.’ P.75. Further, Morgan (2007) considers that

‘The pragmatic approach is to rely on a version of *abductive* reasoning that moves back and forth between induction and deduction.’ P.72.

For the researcher therefore, pragmatism offered a means to avoid the ontological and epistemological assumptions that make qualitative and quantitative approaches incompatible, instead emphasizing the methodological demands of the study in order to facilitate a meaningful relationship between data types and research questions, recognizing the strength of logical investigation that allows different data types to be jointly co-opted to generate meaning. Accordingly, pragmatism provided a view of reality that does not exist as extremes where deductive and inductive reasoning need not present an unassailable dichotomy that is absolute. Instead, pragmatism could facilitate the recognition of single and multiple versions of reality that contribute to mutual understanding that guides and structures the social world. Within this methodological construct, the research could operate via both internal and external paradigms to achieve jointly acknowledged meanings that enable shared beliefs and actions.

Pragmatism facilitated an agreed understanding of the essence and value of research that embraces both positivism/empiricism and constructivist/phenomenology. It enabled convergence between qualitative and quantitative methods that discards extremes and integrates views of knowledge that can be generalized and transferred between paradigms. Consequently, the researcher opted to be located along a continuum in order to achieve and communicate knowledge and awareness applicable to the human condition. Pragmatism facilitates synergy in describing and exploring outcomes that are neither context specific or generalized as a function of the reasoning

that underpins the research.

3.4.9. Triangulation

Close regard was given to how and when data be collected, with the decision to do so in a concurrent triangulation design (Creswell 2003) in order to converge results for analysis. Creswell(2003) describes this as the most familiar mixed method approach, using a concurrent triangulation strategy where the aim is to use different methods concurrently to triangulate findings within a single study . Triangulation is described as using a combination of methodologies in the exploration of the same phenomenon (Morris and Copestake, 1993) This facilitates multiple perceptions of the same happening, providing further information and better understanding in a broader and more comprehensive way. Triangulation offered the means to examine different aspects of the same data from a number of viewpoints, in order to obtain the weight of evidence to substantiate the hypotheses. Thus, in combining both qualitative and quantitative methods, the same data could be extensively investigated in ways conducive to developing a meaningful understanding of a previously unexplored phenomenon.

The choice of a concurrent triangulation design was to enhance validity of the findings of the research by explanation of how convergent data are collected and interpreted. A concurrent design was selected in preference to a sequential design as the study set out to collect and analyses different data types in parallel. Greene et al (2007) Creswell & Plano Clark (2007) recognize triangulation as a design where different methods are used to investigate the same phenomena, thus enhancing validity through convergence or corroboration. Paré (2009) in a review of mixed methods

triangulation designs, emphasizes the importance of transparency in reporting and illustrating the stages in the analysis of data and how they relate to the reported inferences and conclusions. Greene (2007) and Flick (2007) provide a framework of the process, applicable to this study as follows:

Focus: Two methods addressing dimensions of same phenomenon.

Timing: Concurrent

Weight: Equal in data collection, analysis or interpretation. Implementation:

Independent to preserve methods' biases

3.4.10. The limitations of a mixed method approach

Although there are advantages in the use of a mixed methods approach, there are some limitations. Cresswell (2019) recognizes the increased complexity of planning, analysing and evaluating data in a mixed method approach. Such complexity may require a team rather than an individual researcher, who may lack expertise in one or other of the areas and the resources to carry out and manage the required tasks effectively. In addition, comparison of different forms of data can be problematic, requiring expertise and determination (Cresswell 2019) not necessarily vested in the individual researcher. Wisdom et al. (2011) expound upon the difficulties of maintaining the quality of the different elements of a mixed methods study where greater time and resources may be difficult to supply.

Hanson et al (2005) also recommend that a mixed method study be conducted by a team, rather than an individual, as in this case. They propose that this approach

requires understanding and knowledge particular to both quantitative and qualitative methods, involving different types and stages of data collection and analysis, often over extended time periods. As two forms of data are blended together, the approach reflects combination of methods, delineated as 'hybrids' by Ragin, Nagel, & White (2004) so that an individual researcher may be disadvantaged in offering sufficient expertise in both approaches, to the detriment of the design and implementation of a mixed method study. Further, there are practical difficulties in ensuring sufficient time and resources to gather and analyses both quantitative and qualitative data, often complicating the research process and inhibiting clear presentation of the stages of the research .

In order to mitigate the limitations of a mixed methods approach, and in recognition of the disadvantages accruing to an individual researcher as propounded by Hanson et al (2005), specific attention was paid to design and implementation issues to ensure that the individual researcher could draw upon sufficient expertise by focusing on those elements of the investigation most familiar to her. Her existing knowledge and experience of gathering data on SV utterances facilitated the use of different elements of recorded samples, bringing a technical expertise to bear that was not available by other means.

Hanson et al (2005) also point out that a single researcher may lack understanding particular to both qualitative and quantitative methods. In order to overcome this potential limitation, the researcher attended a number of training courses at De Montfort University, specific to research practice, and sought assistance from library staff in identifying and assessing relevant literature. An examination of papers

discussing the implementation of a mixed methods contributed to her understanding and practice where guidelines for mixed methods research were presented (Venkatesh et al 2013, Venkatesh et al 2016, Leech and Onwuegbuzie,2011) Supervisors also offered advice and guidance about appropriate research strategies particular to quantitative and qualitative methods, involving different types and stages of data collection and analysis

3.4.11. Summary

The consideration of the appropriate methodology for the research required a review of the available approaches and the underpinning philosophies integral to each. A review of the literature sought information about a suitable methodology for the research where the initial approach included both exploratory and descriptive elements. A consideration of the available approaches and the underpinning philosophies integral to each enabled reflection upon the researchers own ontological, cosmological and epistemological beliefs also informed the decision to make use mixed methods. In addition, the information extracted from the literature review supported an approach that collected qualitative and quantitative data from the same participants, enabling the research to remain coherent while exploring different facets of SV utterances.

The choice of a mixed method approach facilitated exploration of different elements of the same phenomenon, in ways that enabled investigation of different components at different stages. Both qualitative and quantitative methods could provide the means to collect, analyses and interpret data, where methods were complementary, each supporting and enhancing the other to substantiate and validate outcomes. The

combination of qualitative and quantitative methods provided the means to explore the phenomenon of SV utterances in multiple ways, contributing to the efficiency and effectiveness of data collection and analysis to provide a broader and richer picture of the phenomenon of SV utterances. In recognition of the multifaceted nature of a research project, different elements of the research could be undertaken using different methods, capitalizing on the strengths of each method yet using them jointly to enrich and substantiate findings. Consequently, a mixed method design was developed for this research as the most appropriate for achieving the research aims and objectives

CHAPTER 4: METHODS

This chapter details the organisation of the research, presenting the research tools, including the procedures employed, the technology, data collection, organization and analysis of data. The criteria for participant inclusion are outlined and participant characteristics are defined. Finally there is a consideration of ethical issues

4.1. Organisation of the studies

Using triangulation at the data level, the research was designed as four phases, interlinked by the common focus on SV utterances but exploring different aspects of this phenomenon. Data from each phase was combined to jointly produce outcomes in support of the research questions. Digitally recorded samples of SV utterances by participants provided the essential data for each part of the investigation, yet described, assessed and analysed in different ways to meet the aim of each individual

phase.

The following details present the four phases of the research

4.1.2. Phase 1

Phase 1 was designed for the examination and instrumental analysis of recorded SV utterances provided by the research participants. Subsequently, using instrumental analysis the research was conducted as a pilot study to establish a procedure and instrument for identifying and analysing phonetic and acoustic features in SV utterances for comparison with normal speech and whispers. The phase made use of quantitative methods, employing Praat software (Boersma, and Weenink, 2001), a speech analysis programme, to analyse SV samples and display the acoustic and phonetic components. The analysed samples of SV utterances were then compared with recorded samples of the same utterance, reproduced by the researcher as normal speech and normal whisper. Pratt produced spectrograms showing the acoustic and phonetic components in all samples, facilitating description, analysis and comparison of the different phonation types. This enabled SV utterances to be mapped against normal speech and whispers, identifying elements in SV utterances in relation to normal speech.

4.1.3. Phase 2

This phase focused on an examination of the intelligibility of SV utterances, an essential element of the phenomenon, in efforts to establish that utterances were meaningful and potentially communicative. Proof of intelligibility was sought to add to

the weight of evidence that the participants were indeed producing language as (inaudible) meaningful utterances that listeners could perceive as intelligible.

A series of listener tests designed by the researcher (Appendix XV111) used single and contiguous SV words and phrases in closed and open conditions to provide data on listener perception of SV utterances. Quantitative methods were employed to measure percentage intelligibility by the number of words correctly identified by two listener sets of 20 naïve listeners and 20 familiar listeners. Statistical analysis of results provided additional and precise detail of outcomes. The listener tests in Phase 2 provided data on the influence of various categories on intelligibility including semantic and phonetic variables and the influence of naïve and familiar listeners on intelligibility.

4.1.4. Phase 3

Phase 3 was concerned with an examination of the linguistic and developmental levels of the participants, using the content of their SV utterances as the means to assess them. In order to establish that participants could produce meaningful SV utterances, it was necessary to demonstrate that their developmental and linguistic levels were above 0-24 months and beyond pre-linguistic stages, reaching levels when language is known to develop in normal children. The literature search identified a lack of reliable measures suited to the assessment of individuals designated PMLD generally, and their linguistic and developmental levels specifically. Despite the difficulties, Phase 3 sought the means to evaluate the content of utterances as indicators of linguistic and developmental competencies. Three measures were identified to do so as follows:

Performance Scales (P Scales) Department of Education and Testing Agency

	(2014) Performance (P scale) attainment targets for pupils with special educational needs (SEN).
Developmental milestones.	The National Institute of Health (2009) Speech and Language Developmental Milestones
Mean length of utterance.	Brown (1973) A first language: The early stages.

Additionally, Phase 3 reviewed the adherence of participants to rules and procedures that enable language to function as communication in a joint exchange, including prosody and turn taking. Evidence that participants could use these procedures had implications for the ability of participants to operate communicatively, as well as being indicative of their language abilities. Participant responses to questions and comments by the researcher and their own spontaneously contributed observations also demonstrated their knowledge and understanding, and provided insight into their intellectual and linguistic abilities.

4.1.4. Phase 4

Phase 4 was designed to explore the meaningful nature of the participant utterances, as proposed in the hypothesis. In order to assess the ability of participants to use meaningful language, this phase used participant responses to gather qualitative data, using the framework of semi-structured interviews to explore the capacity of the participants to respond to the researcher with meaningful utterances. Recorded responses were collated and the resultant material explored for evidence of

‘meaningful’ responses.

4.1.5. Participant recruitment

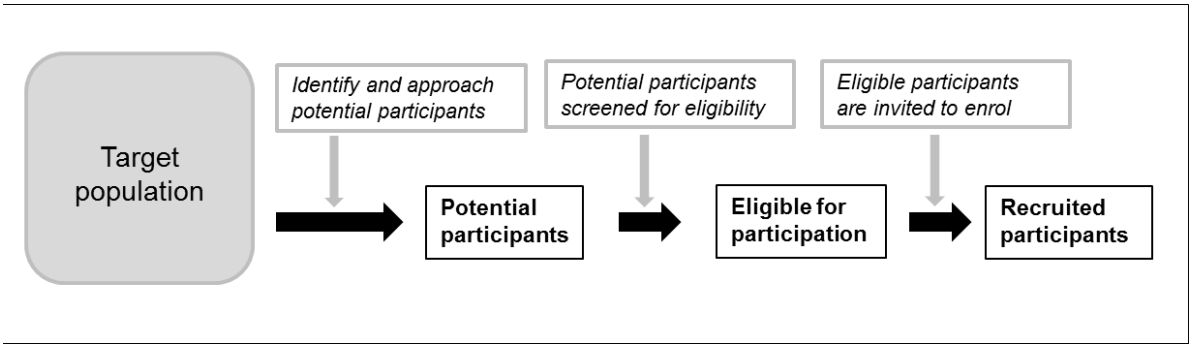
Due to the unreported nature of sub vocal phonation and the inaudible quality of the SV utterances, there was (and is) a lack of awareness of this phenomena in children and adults designated PMLD. Identification and recruitment of participants using SV phonation was potentially problematic as until they were recorded, individuals could not be identified as capable of this form of utterance. This inevitably meant that potential participants could not be invited to participate on the basis of their ability to produce SV utterances. Consequently, participants were sought on the basis of characteristics attributed to this population, rather than the certainty that each would or could produce SV utterances. Therefore, the initial descriptor for potential participants was the designation of PMLD, including the assessed lack of meaningful language due to the pre-linguistic characteristics associated with this designation. Potential participants were required to meet assessment criteria at P4 (Statutory requirements on Performance Levels) and below and show no evidence of verbal or linguistic ability. In addition, complex commnication needs in association with profound physical and sensory impairments were included.

Due to the range of multiple sensory and physical disabilities in potential participants, individuals were geographically constrained, limited by practical considerations regarding travelling or meeting with the researcher. However, the background and experience of the researcher gave access to a range of schools and colleges for children and young adults designated PMLD, facilitating presentation of the research project to other professionals working with this population within the same

geographical area. Subsequently, participants were largely drawn from PMLD pupils in special schools where children or young adults, completely unknown to the researcher, were identified by staff (also previously unknown to the researcher) responsible for communication in the schools. One additional participant, who was well known to the researcher, was resident at a college providing a sensory and interactive curriculum for students with complex physical, learning and medical needs, at pre entry level.

Although 20 participants and their parents agreed readily to take part in this study, awareness of the potential difficulties in recruitment required the application of a planned approach. Gross (2002) Identifies the steps in a recruitment process:

The trial enrolment process adapted from (Gross, 2002) in Hughes-Morley (2017)



Although the stages in participant recruitment are clear, participant recruitment for research studies have been identified as problematic, with a number of issues related to negative consequences for the intended research. Recruitment difficulties are recognised as potentially disruptive to the intended time line of a study (Patel

et al, 2018; McDonald et al, 2006.) but for this research, where participant recruitment was straightforward, recruitment issues, planned in advance, did not delay the study.

Sample size must also be considered and must be sufficient to answer the research questions (Hulley et al, 2001; Keith, 2001) because, where sample size is not achieved, outcomes may not be statistically significant or may reduce the data required as reliable evidence (Patel et al, 2003). Consequently, a sample size of 20 participants was chosen, to ensure sufficient individuals to obtain statistically significant results, yet small enough to enable detailed data collection and analysis for each individual participant. In addition, participants must be representative of the population that is the focus of the research, ensuring valid estimates of the population characteristics being studied (Kukull et al, 2012) in order to ensure that outcomes are generalizable and demonstrate external validity, facilitating appropriate use of research findings.(Ferguson 2004) In this study, the Inclusion Criteria (see Appendix XI) encompassed the criteria that designates individuals as having profound and multiple learning disabilities so that only individuals already designated as such were invited to participate.

For this research, recruitment required not only the participants but also the parents who must legally consent. Therefore, recruitment must encompass both parties, seeking consent and maintaining on-going satisfaction with the research process. Due to the acknowledged difficulties in participant recruitment for research studies, theoretical models of recruitment research have emerged and were considered in

respect of parental agreement for their child's participation. Due to the relationship between the potential participant and their parents and the emotional investment in their child, The Theory of Planned Behaviour (TPB), associated with the Theory of Reasoned Action [406], [407] was applicable. This theory identifies the basis for facilitating behavioural change and is structured as a predictive and motivational model that conjoins three elements:

- Attitude (is the individual in favour of doing it?) '
- Subjective norm (Is the individual aware of social pressure to do it?)
- Perceived behavioural control' (does the individual consider themselves to be in control of the action?)

Subsequently, when potential participants were identified, meetings with the parents, education staff (who had identified the potential participant) the researcher and the potential participant were arranged. The intended study was explained, in conjunction with SV samples, and the benefits and disadvantages explored. Documentation recorded the intended process and included what would be required of any participants and specified their right to withdraw at any point. Recorded SV samples were to be returned to the participant and their parents at completion of the research. Anonymity was guaranteed and data protection ensured by the use of pass word protected files. Parents were then provided with documentation to consider at their leisure, to be forwarded to the school at a later date if agreement for their child to participate was to be given.

The elements of the TBA model were demonstrated during meetings with parents.

Attitude: Parents were in favour of the research, most expressing their willingness

for their son/daughter to experience an approach that might be helpful to them. Even where parents doubted the capacity of their child to produce SV utterances, they were willing to enable them to sample something that might be of benefit, even if outcomes could not be guaranteed.

Subjective norm: All parents had received letters inviting them to the meeting (and including a brief description of the intended research) and it was apparent that some discussion via friendship groups and social media had taken place. Parents as a group appeared keen to meet the needs of PMLD individuals, several commenting that they hoped the research would be of benefit to other children and young adults, if not their own.

Perceived behavioural control. As parents of children in education, parents were aware of their rights regarding their children and the necessary ethical documentation given to them reaffirmed their right to withdraw from the study at any time. Throughout the study, parents were invited to meet with the researcher and their child to hear and comment on recordings, ensuring that they were aware of the on-going outcomes of the study. Control of their child's participation in the study was ensured. Of twenty one (21) sets of parents invited to give consent to the participation of their child, only one (1) set did not consent.

4.1.6. Informed consent

In seeking ethical approval for this study (See Appendix XI: Ethical Approval) it became apparent that there are significant problems in research that focuses on issues concerning individuals designated PMLD. Iacono (2006) reports that problems in

obtaining consent, and in defining who can give consent may constrain efforts to include PMLD individuals in research studies. Boxall & Ralph (2009) also consider that increased regulation regarding ethical consent can be problematic for research subjects believed to be incapable of understanding the intended research or unable to give their own informed consent.

Informed consent for participants in this study was guided by legal requirements. Consent for children was given by parents as described above. Under the Mental Capacity Act all research involving people aged 16 and over who lack capacity to consent must be approved by a Research Ethics Committee. This approval was obtained, as above for all the children and young adults in the research. In addition, reflecting the central premise of this study, issues regarding consent acknowledged the ability of participants to use and understand language at levels beyond that of infancy. Theoretically, they would be able to express their own consent (even at a basic level) although this could not be in itself sufficient in law. Consequently, in addition to Ethical Consent and parental consent, steps were taken to ensure that participants were also aware of what was involved in the research and gave their own consent. Participants were invited with their parents to be given information about the research, the benefits and risks, complaints procedure and confidentiality of the project. Signed consent was sought from, and given by parents/carers on behalf of the participants. Participants were also invited to record their own consent, in the expectation that they were capable of having sufficient understanding of the intention to record them, and sufficient SV responses to demonstrate that understanding. Throughout the study, participants were invited, but not required to contribute, and they consistently demonstrated their readiness (and their delight) in recording

samples, clearly recording that they were happy to do so. However, their understanding of the full implications of the study, for example the transfer of anonymous samples to the internet, could be less certain. Indeed, the need for anonymity was occasionally contested by participants who wanted to let others know about their ability to 'talk.'

Despite the willingness of some individuals to inform others of their utterances, their anonymity as research participants was maintained. Identification of individuals was by code and real names were deleted from recordings. Data was stored on key pens, accessed by codes known only to the researcher and her supervisors. Due to the novelty of SV utterances, utterances on recorded samples could not be recognised as the recorded voices had not been previously available for others to hear. In addition, SV utterances do not sound like 'normal' speech, being sufficiently atypical as to confound efforts to identify individuals.

4.1.7. The nature of participants

As noted above, individuals are designated PMLD by medical professions and educational psychological assessments (Rees, 2017) as were the research participants. They are characterised by neurological problems, severe physical and sensory impairments and significant health and respiratory problems. They have very complex learning needs, with limited responses to a range of teaching strategies. Formal assessments attributed intellectual and communicative delay such that they were unable to demonstrate developmental or linguistic stages above that of infancy. Appearing to operate as pre-verbal and pre-linguistic. All of the participants were wheelchair users, significantly impeded in any use of their limbs, resulting in very restricted interaction with their social or material environment. They required a very

high level of personal care and support and were unable to operate independently. Inevitably, due to their complex health and medical needs in association with their presumed developmental delay, curriculum provision included a range of 'care' tasks, essential to meet physical and medical requirements as well as being responsive to their assessed needs as 'infants.' Thus, large parts of the day were given to physiotherapy, movement via hoists and feeding and changing individuals, all of whom were doubly incontinent.

4.1.8. Assessment of participants

In order to include individuals designated PMLD, educational assessments using National Curriculum Performance Scales (P scales: attainment targets for pupils with special educational needs (SEN) Department of Education and Standards and Testing Agency) that designated participants PMLD were used as the baseline criteria for admission to the study for 18 individuals. Performance Scales are a statutory requirement and standardised across all special schools where participants were attending, or had attended (some having left during the course of the study.) The designated P levels are used in conjunction with descriptors that show the range of overall performance that pupils might demonstrate. P level assessments are not subject specific at the levels attributed to participants (P4 and below), but, for the purposes of this study, behaviours that have been identified as communicative were referenced.

Individuals were invited to participate in the study if the last assessment by their teacher/s, prior to their entry to the research study, recorded P1 – 4. Two participants had moved to post 16 classes when joining the study, where P level assessments were not a statutory requirement. Nevertheless, the individuals were invited to join on

the basis of their most recent P level assessments, prior to joining the research.

Two pupils below 5 years were invited to join the study, assessed by their teachers on EYFS (Early Years Foundation Stages) an assessment used for children under 5 years. EYFS, like P levels is a statutory requirement and standardised across special and main- stream provision. Subsequently, because the two participants attained P Level targets during the research, they were also assessed against Performance Scales in order to present coherent data reflecting the abilities of all participants using the same criteria.

A total of 20 participants contributed to the study. Some took part during the entire period of the study, others joined or left at different points.

For all but one of the participants in this study (Participant 13) the designation of PMLD had been attributed during early infancy or at birth, and continued to be maintained by ongoing assessments. Prior evidence of competence could not be demonstrated. For Participant 13, the designation of PMLD occurred as a result of a major stroke subsequent to which NHS assessment procedures and a nationally recognised assessment centre designated him as PMLD, as did teachers in his special school. Prior to this, he attended normal secondary school, using normal language commensurate with his age.

Before joining the research, Participant 20 reached P5b when assessed on Performance Scales in 2014 as a pupil at a special school but deteriorated in conjunction with a terminal condition, demonstrating competence at P4 for entry to the study in 2017. Except for 1 individual (Participant 1) all participants were unknown to

the researcher.

See Inclusion and Exclusion criteria for participant inclusion Appendix XII

See Appendix XIII for participant details including date of birth, gender, learning disability and medical diagnoses contributing to the designation of PMLD

4.1.9. Sample size

The number of participants (20) was limited by the difficulties identified above. Similar research into comparable groups is not available. As there are no studies into sub vocal phonation and PMLD individuals, comparison has been drawn with studies into motor speech disorders, where sample size provides a norm. In such studies, participants are frequently limited to a small number of speakers, from whom samples are obtained. Shearer (1982) acknowledges the legitimacy of small scale studies, including one subject studies, and notes that studies incorporating a small N generally report data acquired from four to eight participants. Borrie et al (2011) present a summary of previously published studies on perceptual learning of dysarthric speech, all of which were conducted using a small cohort of speakers. Eight studies are included showing that speech samples were obtained from between 1 and 12 subjects. Four studies use only 1 subject while the remaining three studies include 5, 9 and 12 speakers respectively. In contrast, the inclusion of 20 participants in this research reflected the need to include sufficient participants to be statistically significant yet small enough to facilitate the collection of detailed data from each individual.

A difficulty in sample size lies in ensuring that participants are of similar aetiologies. Warren, Brady and Fey (2004) acknowledge the difficulties in establishing the developmental levels of PMLD individuals, where physical and sensory impairments

compromise performance or demonstration of competence. The range and variation of aetiologies associated with PMLD children and adults limits efforts to establish a coherent sample because developmental and behavioural similarities cannot be established. As a result, Warren et al., note that research studies of PMLD individuals often rely on small numbers of participants at the same general developmental level, despite mixed aetiologies. As can be seen from the biographical data on participants (Table: 4.1 above) the range of aetiologies and medical conditions is wide, so that no specific condition could be attributed to participants overall.

Despite acknowledged difficulties described above, 20 participants, designated PMLD by clinical and educational assessments, were recruited. This sample size was selected to be large enough to make manifest any significant variations in the population, while remaining small enough to facilitate intensive investigation of each individual. Originally, a gender balance was achieved with 10 male and 10 female participants, subsequently changing to 11 males and 9 females during the course of the study due to the loss of two participants. There is a range of aetiologies across the cohort, as anticipated by Warren et al, but the characteristics of participants ensured a homogenous balance as far as possible

4.1.10. Data collection

The data was comprised of digitally recorded samples of sub vocal utterances (SV) by the 20 participants. This data provided the core material for the thesis, contributing in different ways to all the studies.

Within the four phases of the study, the data was described and analysed for:

- The acoustic/phonetic characteristics of the utterances

- Listener intelligibility of the utterances -
- Linguistic and developmental levels of utterances
- The meaningful nature of the utterances.

Participants provided digitally recorded samples of SV utterances:

- As answers to specific questions
- As spontaneous utterances (when invited to ‘Say whatever you want to for one minute.’)
- In imitation of words or phrases requested by the researcher to demonstrate competence (or otherwise) in articulation/pronunciation.
- As responses during conversations or interviews with the researcher and others.

4.1.11. Recording methods

Recordings of participant SV utterances were between 1 and 14 minutes long, and were collated throughout the period of the research. The number of recordings per individual varied. Some participants contributed recordings weekly during term time throughout the study, remaining at the same special school, others joined or left at different times, thereby recording less than pupils who were always there.

Recordings were made at the school or college where participants attended and at family homes. In educational settings, familiar staff accompanied the pupils (who were unknown to the researcher) and family members remained present during recordings in home settings.

The majority of the recordings were made in a silent environment by the researcher

and participant, using the same procedure for all recordings. Some were produced by other adults, such as school staff in the absence of the researcher, ensuring that the recording process could be replicated by others. The average length of a recording was 5 minutes although some individuals commonly exceeded this. The limitations on the length of recordings reflected the need to ensure that respiratory effort was not excessive as many participants had significant respiratory difficulties in connection with medical conditions. In addition, efforts to produce SV phonation appeared likely to contribute to fatigue in participants and recording sessions were therefore limited in duration.

Participants were asked to 'speak in your soft or whispered voice for the computer to record.' During their first recording session, the process was explained to each individual, using language commensurate with age, without regard to previous assessments of developmental levels. Samples were elicited by the researcher speaking directly to individual participants and using normal, voiced phonation. Participants responded with sub vocal phonation. Some participants also responded with distorted, audible vocalisations, possibly dysarthric efforts to produce audible responses. These responses were retained for subsequent examination (separate to this study) for adjustment of distorted vocalisations following Rudzizk (2011.) This data was retained, viewed as the property of the participants, and potentially meaningful to him/her if technology enabled interpretation at a later time.

The researcher tried to remain silent during the period when sub vocal phonation was anticipated, to ensure that her voiced comments did not obscure participant SV responses. However, it was often not possible to recognise when sub vocal phonation

was being produced as there were no obvious movements of the jaw or mouth to cue the listener. (With some participants, tongue movements could be observed if the mouth remained open.)

Sub vocal responses by participants remained inaudible while being recorded, only becoming audible with later amplification. However, due to the gaps left by the researcher for the participant's response, recordings present a 'turn taking' dialogue as the researcher left gaps for participant responses to the initial comments of the researcher. Participant responses also maintained a turn-taking sequence in conversation or when asked questions, responding initially then waiting for the researcher to proceed again. Recorded utterances were played back to the participant providing the samples. For all participants, this appeared to be the first time that they had heard an audible playback of their own sub vocal voice.

4.1.12. The equipment

A Toshiba laptop computer, using Adobe Audition 1.5 sound software, recorded the inaudible phonation. More than one Toshiba laptop was used in the course of the study, and there were variations in the sound quality of recordings from different laptops, dependent upon the quality of the integral sound card.

4.1.13. Microphones

- All microphones were used in EV (Edit Mode) selected within the Device Order menu.
- The recorded sample was played back at a sample rate of 44100 Hz, where the value is the number of samples captured per second in order to represent the

waveform.

- Speakers were set at 100.

Prior to the study, different microphones were tested for the quality of recording of SV utterances. See Appendix XIV: Microphone trials

4.1.14. Blue Yeti microphone

Following microphone trials, the Blue Yeti Microphone produced suitable results and was selected as a relatively reliable means of capturing the inaudible SV production. Participants were therefore recorded via a Blue Yeti microphone on cardioid setting, placed approximately 15 cms from the participant's mouth. Recordings were played back to participants via Adobe Audition sound software on the laptop computer.

4.1.15. Sound box microphone

An additional bespoke microphone was constructed as part of this study, in conjunction with a 'Sound Box' used with headphones that enabled participants to listen to their own sub vocal phonation in real time as they recorded. See Appendix XV: Sound Box. Participants could listen to themselves independently using this system or could be recorded by the Sound Box microphone via a USB connection onto the laptop. As the participant 'spoke' the components in the headphones amplified the sound back through the headphones to the ears. Some participants delighted in this experience and consistently used the Sound Box, listening to their own voice when recording.

4.1.16. Skype microphones

During the final year of the study, microphones integral to Skype software on the Toshiba laptop were also employed, where participants could produce sufficient amplitude (generally dependent upon respiratory energy) to activate the software.

4.2 Digital Recording

Due to the inaudible nature of this phenomenon, digital recording of samples of SV phonation were initially challenging, requiring a suitable means of capturing and recording the inaudible data and subsequently amplifying and processing utterances for playback. All samples were recorded digitally (reforming analogue sounds so that the material could be manipulated and stored on computer sound software.) Analogue recordings reproduce the shape of the sound waveform directly, but are significantly degraded by subsequent copying. In contrast, digital recordings operate by sampling the waveform at regular intervals, each sample being represented as a precise number. Digital recordings remain consistent over time and do not degrade when copied. A range of effects can be applied to digitized audio material, including alterations in pitch, amplitude and frequencies to enhance clarity of the sample. At completion of each individual session, the recording was saved as a PCM or ACM Wav file using Adobe Audition 1.5.

4.2.1 Quality of recordings

In defining the quality of the sample, a technical measure of quality refers to sample rate at 44100 Hz and sample format for dynamic range at 16 bit. These parameters are significant for intelligibility for speech at normal levels, where the human ear perceives the sound with a dynamic range of at least 90 dB. However, due to the

inaudible nature of the SV acoustic signal, the capability of the hardware and software employed can be problematic as the design of the products used was not intended to cope with acoustic signals that were initially inaudible.

There were variations in the quality of recordings, due in part to the acoustic quality of the individual's sub vocal phonation and in part to the difficulty in recording the initially inaudible acoustic signals. Due to the difficulty in the quality of samples, on-going collaborative work with Dr.David Kerr and his team at the Wolfson School of Mechanical and Manufacturing Engineering at Loughborough University identified that sub vocal samples could be subject to:

- A lot of redundancy present in the signal that makes general understanding difficult
- Presence of temporal and frequency variations due to intra speaker variability in articulation of words
- Signal degradation due to additive and convolution noise present in the back-ground or in the channel
- Signal distortion due to some non-ideal channel characteristics.

4.2.2. Mitigating the problems

Efforts to ameliorate the problems identified above were on-going as, due to issues with the quality of recordings, it was always apparent that recorded quality could be improved if utterances could be produced clearly and audibly, rather than as part of an amalgamation of acoustic stimuli. The first step in doing so was to ensure

recordings were made using batteries only on the laptops. Direct plug in access to mains electricity produces ambient noise on the recording, eliminated when the laptops were run on integral batteries.

Barker and Cooke (2006) report that noise masks intelligibility. Energetic Masking in the periphery of the auditory system occurs where noise energy exceeds speech energy, masking important speech features (Barker and Cooke, 2006). Thus, reduction in intelligibility is related to the degree of energetic masking compared to speaker acoustics. Listeners, once prepared and anticipating the presence of 'speech noise' in comparison to masking noise, may learn to separate and distinguish between the two, to access the relevant acoustic pattern related to SV utterances. However, if listeners cannot do so, appropriate use of the software and the VSTs (plug-ins to process software) used to process recordings can contribute towards greater clarity, separating speech from background interference and therefore producing samples of improved quality. The additional consideration of the effects of extraneous noise, particularly in classroom settings, both for recording or playback of utterances is important. The use of an environment where extraneous noise is minimal, in conjunction with clear and clean recordings, is positively advantageous. This involved deletion of extraneous noises not relevant to the sample such as playground voices, footsteps of passing individuals, and noises created by the participant such as swallowing, gulping, lip smacking, heavy respiration. As a result, processed recordings provided improved access to the SV utterances. Subsequently, only those recordings that were appropriately processed to achieve the best audible quality were used in the research (particularly in Phase 2 where intelligibility was explored) to ensure that findings were not influenced by problems related to the acoustic quality of

the samples. The procedure is described below.

4.2.3. Processing recordings

Initially, the recording was amplified (minimum 20dB) to enable the researcher to hear where utterances occurred, so that the inaudible phonation become audible and intelligible to the researcher, when played back via the Toshiba laptop. Care with amplification was required to ensure that the acoustic signal was not clipped (when over amplification introduces distortions into the recorded signal.) Amplified playback could also be heard via headphones.

The recording could also create ambient noises on the track such as hum, hiss, crackles and clicks, obscuring the SV phonation. The electronics integral to the laptop computer and the microphone pre-amplifier produced frequencies normally inaudible to the listener but, due to the extensive amplification of the SV phonation, audible on the recordings. Thus, amplification of phonation also amplified ambient noises, often to the detriment of the acoustic quality of the SV utterance. As noted above, best practice was to record on batteries only, thereby reducing (although not eliminating) ambient noise.

In order to remove material obscuring utterances, the acoustic signal was processed and filtered (after amplification) using audio VSTs (Direct X, Waves, X Noise) for mixing, mastering and audio restoration (post production.) They were an essential addition to the process of improving the sound quality of samples, without which many recordings would have remained obscure. Such VSTs, used singly or in combination, typically improve sound quality by reducing ambient noise generated by the recording process or features such as clicks or hiss on the recording. The VSTs used to clear

ambient and extraneous noises from recordings contributed to better sound quality, but could sometimes produce a ‘robotic echo’ quality to the sound sample. In some cases, where the phonation was obscured by noise that could not be removed, the sample was discarded from the research data but retained (as the property of the individual participant) against the possibility that later improvement in the software might induce sufficient clarity for the utterance to be understood.

Due to the tendency of participants to separate words (where they lacked respiratory energy) gaps in contiguous utterances were often deleted if necessary so that the content of utterances were heard as continuous phonation. This was required as many participants produced utterances intermittently, due to respiratory difficulties that limited continuous effort. In some instances, all or part of an utterance was slowed using Effects, Time/Pitch, Ratio 90. Slowed samples facilitated recognition of all elements of the sample, potentially missed where phonation was produced rapidly. This appeared to occur where participants attempted to complete phonation ‘on one breath’ as it were, using limited respiratory energy rapidly, in contrast to utterances where words were separated and extended to capitalise on available respiration.

4.2.4. Implications for the research

The procedures for mitigating problems impinging on the quality for recorded samples could not change the content of the sample but could and did improve the sound or signal quality and thus enhance the overall quality of the recordings. Although these procedures were time consuming and sometimes technically complex, they were a necessary and beneficial contribution to the clarity of recorded utterances. This meant that sufficient time and effort had to be incorporated into the study time frame

but offered advantages in:

- Comparison and analyse of acoustic phonetic features
- Playback of their recordings to participants
- For playback of utterances for information and discussion during agency, staff or parent meetings.
- Facilitating transcription of recorded material,
- Preparing samples for intelligibility testing

4.2.5. Identifying recordings

Original recordings were identified as: Participant number: Date (of recording.) Code number (to main anonymity)
Recordings were saved in folders, each participant having their own separate folder.

4.2.6. Processed recordings

Original recordings were processed as described above (Processed recordings) to enhance the content throughout the length of the track to identify those sections suitable for transcription. As a result, the original track was adapted in all areas where processing had occurred. These altered originals were identified as:
Participant number: Date: Processed, Code number

4.2.7. Cut and pasted recordings

Utterances on the adapted recording that represented the best quality sound were selected for transcription. These were removed from the processed track, being cut and pasted on to another new track. The original track was retained in its entirety,

against the possibility of later transcription if advances in technology enabled increased clarity in material currently obfuscated. Thus, the cut and pasted track contained the best quality utterances from the overall individual recording. The utterances from the cut and pasted tracks provided the samples used for this study.

Cut and pasted recordings were identified as:

Participant number: Date: Cut and Pasted, Code Number

4.2.8. Transcription

Utterances were orthographically transcribed by the researcher. The accuracy of orthographical transcription relied on the subjective ear of the transcriber, but this approach has been recognised as a legitimate means to extract meaning from disordered speech and is commonly employed in intelligibility tests (Hustad 2006) However, transcription could be problematic. Despite a range of techniques to process and improve recordings, variations in the acoustic quality of utterances reflected variations in the phonation within and between different participants. Some individuals appeared to rely heavily on their breath, both as the source of energy and manipulated as sound. They produced utterances as very ‘breathy’ words, particularly where respiratory problems were evident, so that words were almost cloaked in breathing sounds. Using the software to process these samples could often produce a ‘robotic’ quality to the phonation. Other participants appeared to articulate quite precisely, albeit inaudibly, yet producing sharp, precise words that, once amplified, clearly hit the majority of articulatory targets. Individuals producing precise phonation may have produced their words as ingressive speech (inhaling instead of exhaling) reported by

Hackaday (2020) as efficient as normal speaking. Certainly, some participants had very good SV phonation, producing utterances that appeared better phonated and better articulated than others, sounding very like normal speech when amplified. Thus, variations between participants required variations in processing, with some utterances inevitably better and clearer than others.

Due to the variations in the quality of the phonation (and of the recording) only samples that were most easily perceived by the researcher were selected for transcription.

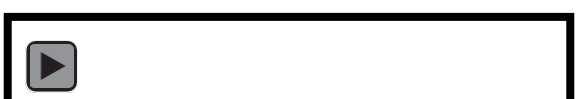
Despite efforts to ensure that transcriptions were correct, Bowen (2011) stresses the difficulties in collecting language samples produced by children with many speech sound errors. Although SV phonation is not the subject of extensive research, the likelihood that participants did exhibit ‘speech’ errors as part of their SV phonation could not be discounted. Context aids interpretation (Hustad, 2000) as did the increased listening experience and therefore familiarity of the researcher (Liss, et al., 2002) but in order to ensure authenticity, individuals were asked at intervals to confirm or refute their transcribed data.

Transcribed utterances were played back to the participants who recorded the material. The researcher read the transcription to the participant, in conjunction with the play back, for verification and confirmation by him/her. The participant was asked to authenticate transcribed utterances by confirming the content with a recorded (SV) response.

Participant 16 hears his SV samples and confirms or refutes the researcher’s transcription.

Chapter 4 a sample

Participant 16: You were right



Little bit wrong

Carers, families and familiar others were also asked to authenticate transcription, where content referred to activities or knowledge specific to them. For example, Participant 13 told the researcher about his 'new' bathroom, and parents confirmed the on-going installation of a new bathroom. Participant 2 told his assistant 'You bumped me,' after she bumped his wheelchair and the assistant confirmed that his comment to was correct.

Subsequently, towards completion of the research project, recordings were also moderated by three additional adults, to confirm or otherwise the transcription by the researcher. This group included the class teacher of some of the participants, the Deputy Head of a special school from which participants were drawn and the former Head Teacher of a special school unconnected with any of the research participants.

4.2.9. Transcription conventions

There are advantages in maintaining transcription conventions but such conventions are not necessarily required according to Braun and Clarke (2006.) while still recognizing that the main function of orthographic transcription is to capture the words used as precisely as possible. This guideline was applied to the transcription of SV

utterances, where the varied complexities of the aetiologies of the different participants had varied effects on their production of utterances. The essential task therefore was seen as correct reproduction of the words used, rather than concern with details such as the length of pauses between words. Where difficulties with the quality of the recording made words uncertain, they were retained as samples but not used to contribute to the research. Efforts to ask participants to clarify uncertain words were not undertaken, assuming that initial difficulties in clarity might not be overcome at a later attempt, and possibly impacted by the time delay caused by the gap between processing and transcribing the content.

4.2.10 Summary

This chapter has presented the methodology underpinning the research approach and the technical methods used to investigate the production of meaningful SV utterances by children and young adults designated PMLD. A mixed methods approach was considered to be most appropriate in meeting the aims and objectives of the research, offering the flexibility to call upon qualitative or quantitative techniques separately or in tandem to gather, describe and analyze data. Throughout the research project, the synergy of quantitative data and qualitative data provided a context that facilitated a wider and more comprehensive understanding of the data overall. Thus, a mixed methods approach provided more extensive data to contribute to consideration of the research hypotheses, especially useful in providing a fuller, more detailed account of this previously unrecognised phenomenon. Due to the novel nature of the phenomenon of SV utterances by participants designated PMLD the technological details of the recording process were reported and described, particularly to facilitate replication of this approach in additional research studies. The approach to recruitment

of participants and ethical issues were explored with regard to problems in obtaining consent for participants designated PMLD

The following chapters present the 4 studies referred to above.

CHAPTER 5: Phase 1

5.0 Introduction

This chapter addresses the research question:

How do the SV utterances compare acoustically and phonetically with normative samples where instrumental analysis allows comparison of the acoustic phonetic features?

Phase 1 was designed to examine the acoustic phonetic features of SV utterances. Although SV utterances could be amplified and heard, proof that these were more than meaningless vocalisations was required. Evidence of speech like features were sought in SV samples by 6 of the 20 participants where recordings produced the best acoustic quality. Using a quantitative methodology, Study 1 was designed to identify an appropriate analytical tool to enable identification of the features of SV utterances. A second purpose was to demonstrate the use of the analytical tool as a means to

compare acoustic features in typical speech and whispers with SV utterances. Data reflecting similarities and differences in the three forms of phonation were sought.

Phase 1 is presented in two sections. Section One explored the instrumental tools available for analysis of speech. Section Two demonstrated how instrumental analysis could contribute to the study by comparing features and characteristics in SV utterances with normal speech and whispers.

1.1. Rationale for instrumental analysis of utterances.

Although SV utterances by the participants could be recorded and understood, it was not possible to accurately determine the means by which the phonation was produced and the features and characteristics integral to it. Observations during recordings identified the lack of movement of the primary articulators during SV utterances, demonstrating that the participants were not articulating in the manner typical of normal phonation. The consideration of whether the sounds produced were more than vocalisations, related in some way to verbal performance was paramount. Thus, an exploration of the production of SV utterances was apposite, including consideration of the acoustic phonetic elements of the sounds produced. As intrusive physical examination of participant phonation was both unethical and impractical, exploration of acoustic performance offered a viable alternative. Reference to the extensive information about phonation in both normal and disabled speech provided a template against which SV phonation by people designated PMLD could be considered (while not assuming conformity to existing knowledge of speech production.) Consequently, a means to examine and analyse SV phonation was sought. In doing so, the objective was not to analyse a range of utterances by participants in this research but rather to

identify and pilot a technique that would provide the means to do so. Due to the wide variation in participant aetiologies and the wide variations in the quality of their SV utterances, a reliable, credible and recognised system that could be applied to the phonation evident in all utterances was required.

Miller-Keane (2003) described phonation as the utterance of vocal sounds. The sounds are defined as ‘speech’ or ‘articulation’ when produced as words. The production includes both acoustic and phonetic elements that contribute to intelligibility. For this study, where intelligibility is a central tenant, the presence and nature of acoustic and phonetic features pertaining to speech were considered significant. A method to analysis and to identify those features was necessary.

Phonation and speech occur as a consequence of the activities of the oral and nasal cavity in conjunction with the pharynx, larynx, vocal folds trachea, bronchus and lungs. An air flow into the oral cavity is manipulated into different shapes, by use of the active and passive articulators. The active articulators are those that can be controlled, such as the tongue, lower jaw and lips, while the passive articulators are those that are not subject to control such as the hard palate. The generated sound resonates through the vocal tract to create speech sounds as a result of the integration of phonation control and the motion mechanisms of the speech structures. Acoustic outcomes result.

5.2. Acoustic analysis

The signal properties of the phonated sounds that are created as described above comprise acoustic and phonetic features. Acoustic analysis of speech sounds has

been recognised as the most scientific way of describing the elements, features and characteristics that comprise speech (Ladefoged 2005.) and derives from seminal work by Fant, facilitating understanding of articulatory- acoustic interaction. Fant's theory proposes a linear, or straight line input-output energy source where the output energy, often referred to as the radiated speech signal, is directly formed by the joint action of the energy source that is the lungs where the air stream initiates and the resonator that is the vocal tract. The vocal tract is essentially a pipe resonator and can have an infinite number of resonant frequencies. As air passes through the vocal tract certain frequencies are enhanced through resonance and these are known as formants. Kent (2001, p.24) defines this as 'a natural mode of vibration (resonance) of the vocal tract'

Speech sounds arise as a consequence of air containing many frequencies of vibration passing through the vocal tract and being manipulated by the articulators in a range of ways and locations. The varying shapes of the vocal tract then give rise to different energies in the speech sound wave which are associated with different resonances and with different speech sounds. All speech sounds have enhanced resonances arising from the type and location of constriction in the vocal tract. Each speech sound has a voice print, a set of acoustic characteristics that can be used for identification. As speech is dynamic the acoustic features and energies change rapidly as the vocal tract shape changes. These changes or transitions in formant frequency can be used for identification.

For most languages the origin of the energy i.e. the source of the air that is used to make speech sounds, is the lungs. For certain speech sounds such as vowels there

is minimal constriction of the air stream in the vocal tract and the vocal folds are vibrating. This results in highly resonant, periodic speech sound wave which can be represented as a sound spectrum; amplitude plotted as a function of frequency of vibration. It shows the strength of the relative frequencies and how these change when the mouth shape changes for different vowel sounds. For voiced sounds most of the energy is in the lower frequencies. Each vowel sound has enhanced resonance at certain frequencies which is manifested as formants. They have characteristic formants which are the direct result of the shape of the mouth. Formants can used to identify vowels and indeed can therefore be used to determine approximate mouth shape.

The production of speech both typical speech and whisper presents as phonatory variations, vocal fold vibration or lack of vibration and a range of types and locations of constriction in the vocal tract. The relationship between articulatory movements, the energy source and the resultant speech sound means that analysis of the acoustic elements of voice has become commonplace, particularly with regard to the study of intelligibility (Whitehall et al, 2006; Ferguson and Kewley-Port, 2002; Most et al, 2000.)

Generally, acoustic analysis has focussed on speech sounds because this represents typical speech but whispers, can also be analysed. Whispers have been of limited interest to researchers, having little communicative function so that the features and characteristics of normal whispered speech have not been the subject of extensive research (Sharifzadeh et al 2012.) Nevertheless, for this study, where the inaudible nature of the SV phonation suggested a possible association with whispered speech, comparison and analysis with this form of phonation was included. Whispers are

phonetically different to normal speech, both acoustically and in the manner of articulation. Whispers are produced without vibration of the vocal folds. Instead, they are adducted sufficiently to produce audible turbulence created by the exhaled air of the speaker (Morris and Clements, 2007; Ladefoged, 2005.) Thus, the vocal folds which are responsible for affecting various phonation types are held together in a different stricture to that for normal speech and produce vibrating air in the front of the mouth (Ladefoged 2005). Whispers are audible at between 15dB – 40dB (Philbeck and Mershon, 2002) in marked contrast to SV utterances where amplification is necessary to make the initially inaudible utterance audible.

5.3. Praat speech analysis software

Acoustic analysis of speech sounds has been recognised as the most scientific way of identifying and describing the elements, features and characteristics that comprise speech (Ladefoged 2005.) Praat (Boersma and Weenink, 2007) an open source speech analysis software programme performs this function. Brett (2004) described the use of Praat for learning vowels and diphthongs, while De Jong & Wempe (2009) advocate the use of Praat to identify syllable nuclei, demonstrating the presence of vowels in relation to consonants. Praat provides the means to visualise, describe and compare SV utterances with normative speech samples, using spectrographic analysis of vowels. Ladefoged (2005) acknowledges sound spectrograms as a powerful tool for describing speech sounds. A sound spectrum is a visual representation of the acoustic features of speech sounds where frequency of vibratio, Hertz (Hz) is plotted as a function of time, seconds (sec). Due to the ease and accessibility of this resource, in conjunction with the many appropriate features, Praat was selected as a suitable tool for the analysis of SV utterances. In order to explore

the features and characteristics in SV utterances, the analysis drew on the composition of normal speech and whispers against which to compare features in SV utterances.

5.4.The procedure for analysing SV utterances

Phase 1 was designed as a study to identify the means to analyse SV utterances. Having identified Praat as an appropriate analytical tool, the research demonstrated how this could be used. The process is detailed below.

The SV phrase ‘My voice,’ produced by Participant 2, was used initially to establish the procedure for analysis. The phrase by the participant was digitally recorded and the content identified and transcribed (authenticated by the participant.) The researcher repeated the participant’s SV utterance, using normal spoken and whispered voice. The participant’s raw SV utterance was below the threshold of hearing and required amplification to become audible. It was also processed to remove extraneous and ambient noise unrelated to SV phonation. The researcher’s recordings (whispered and spoken version of ‘My voice’) were retained as raw samples. Despite the difference in quality between the participant recording and the researcher’s recorded imitation, the identical content of the recordings provided data for description, instrumental analysis and comparison of the same utterance.

Recorded samples of the voice of Participant 2 and the researcher’s whispered and spoken imitation of the same phrase (My voice) were entered into Praat. The Praat software produced spectrograms where the frequencies and resonances of sounds were graphically represented. The spectrum displays Time on the horizontal axis, with

Frequency on the vertical axis. Thus, the spectrogram displays the characteristics and features of the sound wave and changes occurring in the sound over a period of time. Praat was used on standard default settings with the maximum formant set at 8000.0 Hz for a young child (due to the anticipated higher pitch of the 12 year old participant), and 5500.0 Hz for the female researcher, as recommended by Praat. This refers to the vertical axis of the graph. Similarly, the time step (how much detail is represented on the horizontal axis which refers to time or length of the speech sample) was set at Automatic as recommended by Praat, at 0.01 for approximately 200 analysis frames to extract 5 formants per frame.

NB Praat's standard time step for formant measurements is the Window Length divided by 4 (Praat Manual: Automatic time steps)

5.5.. Identifying speech characteristics

The spectrographic analysis concentrated on vowels in the phrase 'my voice' for the following reasons:

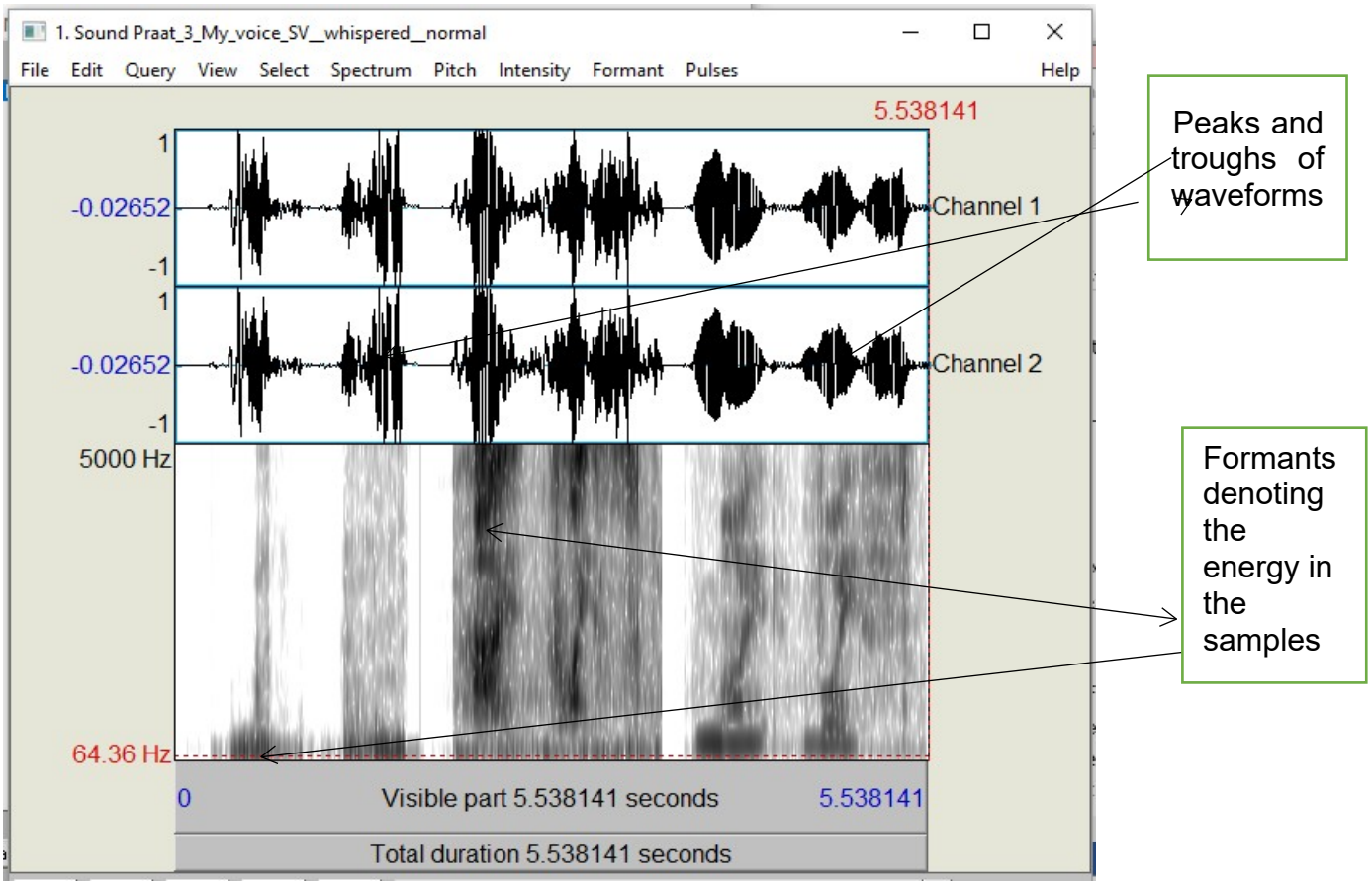
- Vowels are the core of every syllable both phonologically and phonetically unlike consonants (Ladefoged, 2005)
- They are highly resonant speech sounds with a very clear formant structure
- Vowels require the least constriction of the airstream as it passes through the vocal tract meaning the articulators are required to move far less than for other speech

sounds, particularly pressure consonants such as plosives e.g. /t g/ or fricatives e.g. /s z/

Vowels carry significantly more energy than consonants (Fogerty and Kewley-Port, 2009., Staab 1988) and therefore have much greater power comprised mostly of low- and mid-frequency spectral energy which is usually easily heard in typical speech. Spectrograms established that the participants produce speech atypically, reflecting the problems arising in association with poor muscle and breath control. Additionally, issues associated with the lack of movement of the primary articulators have inevitable implications for articulation. Nevertheless, although in terms of production the participant's articulation may not be typical, vowels require the least constriction of the vocal tract, facilitating recognition and efforts to map SV phonation onto normal sample Typical vowel sounds are voiced with vocal fold vibration and are characterised by formants - concentrations of energy arising from the resonances in the vocal tract. The two first formants, F1 and F2, are generally considered sufficient to disambiguate the vowel and to facilitate perception.

Below is Figure 5.1., a Praat spectrogram, representing the acoustic formations for the participant's SV sample and researcher whispered and spoken samples of 'My voice.

Pratt takes the acoustic sample of the utterance and reproduces it visually, including speech features selected by the user for examination and analysis.



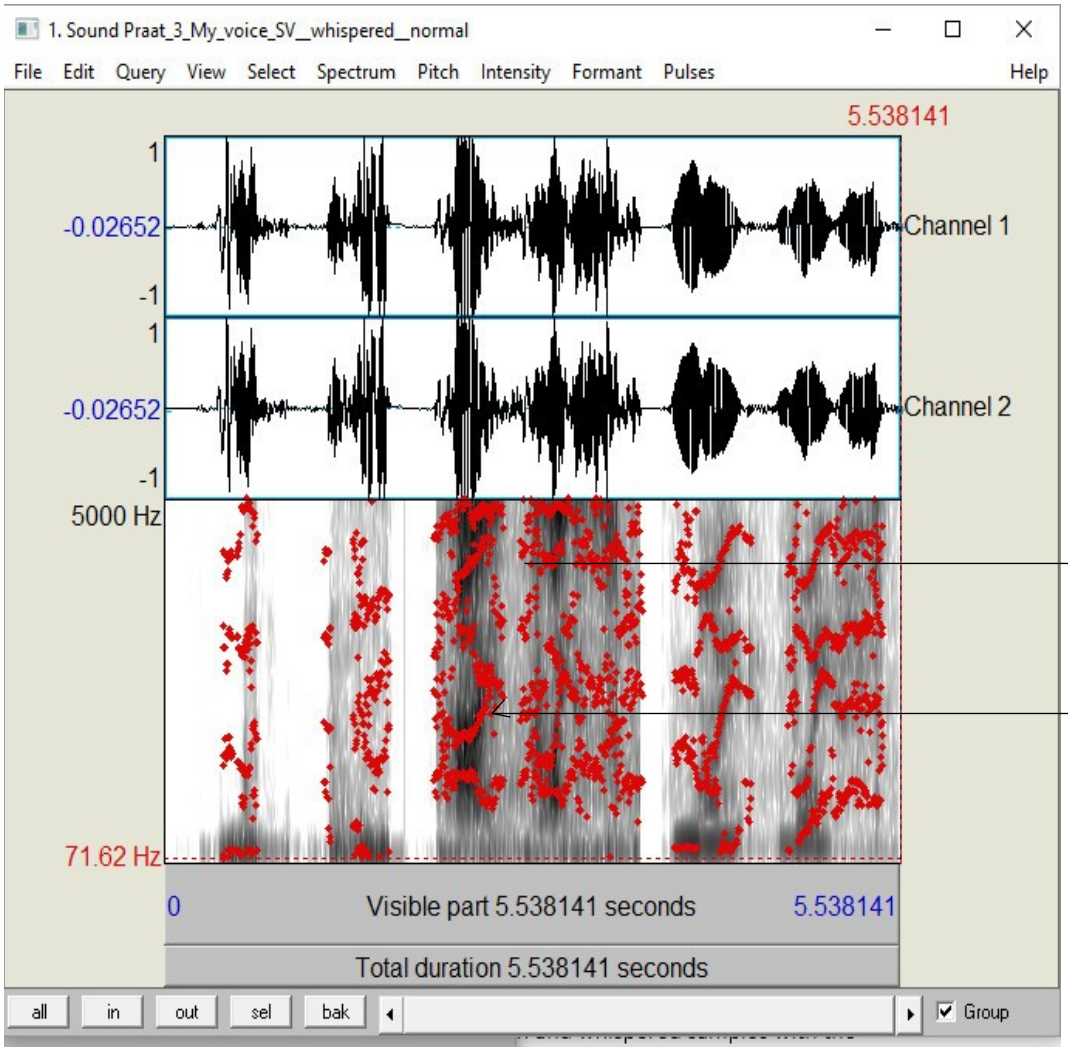
5.6. Vowels and formants

In Figure 5.1 above the formants are in the lower half of the image, while sound waves are displayed at the top of the figure as the peaks and troughs of waveforms. The formants are seen as the dark horizontal bands which are related to the air moving through the vocal tract

It is easier to see the formants in typical resonant sounds, particularly vowels because they are voiced. For voiceless sounds as in SV utterances the enhanced energy that can be seen is the result of natural resonances in the vocal tract responding to the non-vibrating airstream passing through.

In Figure 5.2. below, formants are displayed with an overlay of red on the spectrogram, for ease of identification.

Figure 5.2. Spectrogram with red overlay identifying formants



The distribution of formants in the spectrograms shown in Figure 5.1. and Figure 5.2 indicate the three forms of phonation (SV utterance, researcher whisper and researcher spoken phrase) and identify the similarity in the production of vowels (despite differences in age and gender between the participant and the researcher) The formants clearly show that the oral tract shapes by participant and researcher are as should be to approximate the required vowels. As speech is dynamic, the mouth

shape is constantly changing, meaning that the location of energy, which is represented by darker shading on the trace, is different for different sounds. Energy was clearly present in the same frequencies. Acoustic energy in the same frequencies indicate that SV utterances have features of normal speech albeit produced atypically.

Although the participant produced sub vocal phonation without observable overt movement of the primary articulators (as described above) formants representing oral tract shapes for him show approximate normative vowels, even though, at this stage, it is not clear how the SV phonation of the participant achieves that outcome. Similarities are shown on ‘My’ (at the base of the striated areas) but are less discernible on ‘voice.’ In the lower half of the spectrogram, the SV vowel in ‘My’ can be favourably compared with the researcher’s whispered speech, although the duration and intensity is weaker. There is no evidence of the ‘m’ in SV ‘My’ nor of ‘v’ and ‘s’ in ‘voice’. However the vowel in ‘voice’ compares to the normal whispered sample. Also apparent in Figure 5.1 and Figure 5.2 is the additional characteristic of speech waves made apparent by the shape of the formants.

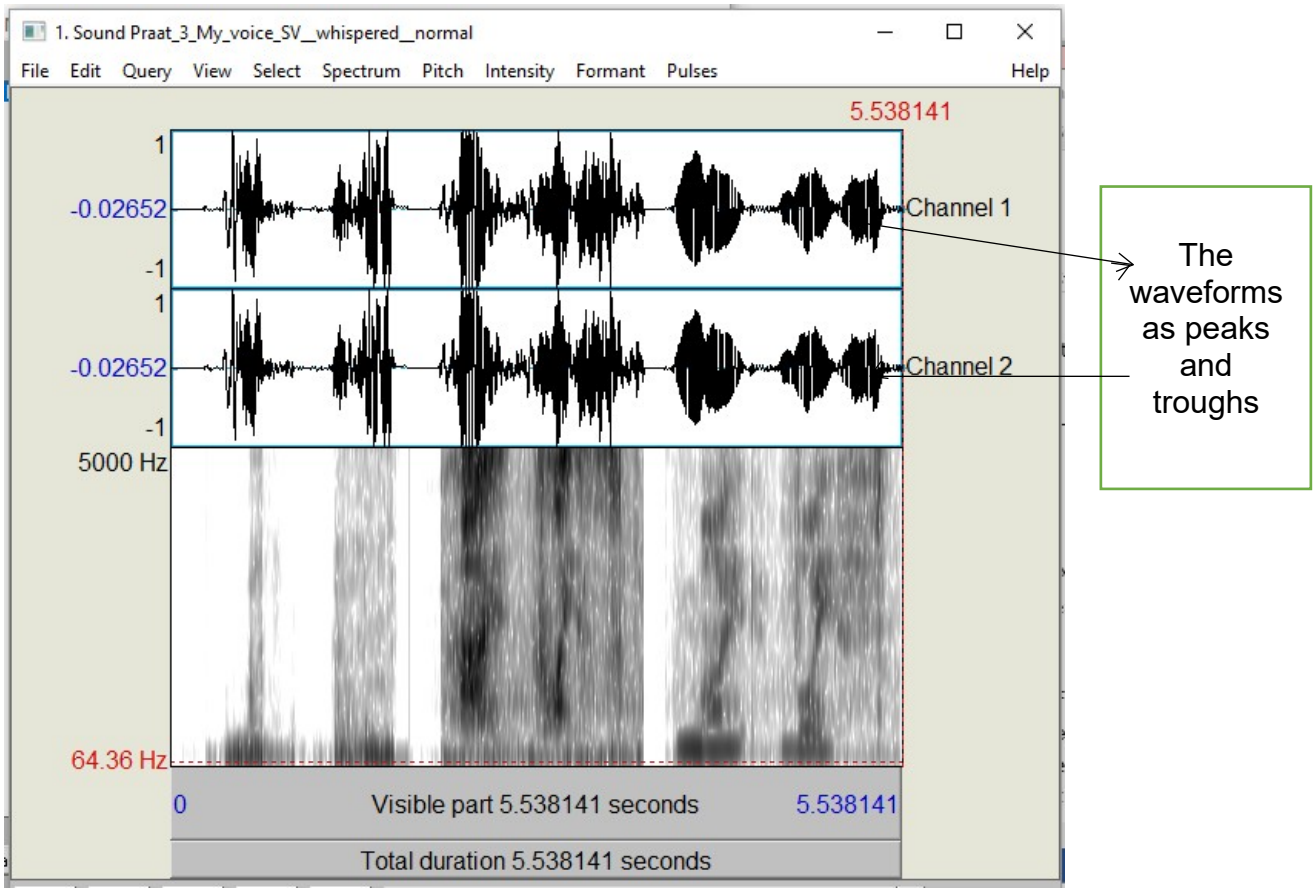
In voiceless phonation, the formants are less clearly differentiated and the formants in the participant sample are less defined, but clearly present. The sub vocal phonation of the participant lacks vocal fold vibration and, consequently, the programmes Linear Predictive Coding (LPC) estimates the vocal tract filter that shaped the sound and displays the software overlay more haphazardly than that of the researcher’s spoken sample. Lack of voicing results in a formant structure that is more random because the software operates more effectively with resonate voiced sonorants. Nevertheless,

similarities are apparent and the ability of the LPC to identify formants reflects the listener's ability to separate the sounds. The word 'My,' by the participant is imprecise, indicating a lack of high frequency content. Despite this lack, the psycho perceptual response of the listener facilitates comprehension of 'My' by fitting the voiceless elements of the participant's phonation onto the perceived word, due to the phonemic restoration effect (Baskent, 2010., Davis and Johnsrude, 2007., Warren, 1970). Formants can be seen on the researcher sample but are less evident on the participant sample, possibly due to imprecise articulation by the participant, in contrast to that of the researcher, where articulatory targets are clearly met.

5.7. Waveforms

The waveforms present as peaks and troughs, appearing on the screen with the on-going recording. Initially, SV utterances may not be visible, appearing only as a straight line until amplified. If the researcher speaks during the recording, the waveforms for her voice will be evident, even in whisper. This helps to identified where the participant's SV utterance may be anticipated (in response to the researcher's comments) making it easier to amplify the appropriate section of the recording

Figure 5.3 Spectrogram displaying the waveforms.



Exploration of this sample is concerned with the waveforms. A waveform is a two dimensional representation of a sound, appearing as peaks and troughs, displaying information about the amplitude and the frequencies present in the signal and tracking changes in air pressure over time as a sound is produced. Initially, using Adobe Audition software, the recorded utterances appeared as waveforms on the computer screen, facilitating comparison and analysis. The waveforms appear continuously as the sound is recorded and are acknowledged as suitable for the analysis of speech sounds (Rabiner and Schafer 2011., Ladefoged 2010., Kent, 1992.)

In Figure 5.3. the waveform for the SV and the whispered sample have been amplified, facilitating comparison with the normal waveform. Thus, in this sample the amplitude

has been artificially increased, and is not a distinguishing feature of the sound wave. Amplitude in itself does not represent a constant acoustic feature that contributes to the identification of individual sounds. Spectral waveforms are measured in decibels (dB) and the SV sample of the participant required amplification of 30dB to be visible on the display and audible as sound to the listener.

Although the similarity of the waveforms is evident, so also is the differences between the participant's SV phonation and the whisper and normal phonation of the researcher. The SV and whispered waveforms represent the random unvoiced nature of these speech samples. They are both aperiodic waveforms arising from the pulmonic airstream and the natural resonances of the vocal tract. The voiced sample produces a wave form that arises through vocal fold vibration and is enhanced through the resonances of the vocal tract.

Figure 5.3. also displays vertical striations, indicative of the presence or absence of vocal fold vibration. In voiced sounds particularly sonorants such as vowels, the lines are noticeably regular because the vocal folds are vibrating and the air is not distorted as it passes through the vocal tract. If the vocal folds are not vibrating then the air stream is random and the striations will not be regular. This is also apparent in the wave forms where the SV and whisper waveforms are very spikey but the waveforms of the researcher's spoken sample are more rounded and regular in appearance.

The waveforms in Figure 5.3. display the presence of vowels. Vowels are louder (having more energy) than consonants and produce a bigger part of the waveform, while consonants will be visually identified as a smaller, darker section inside the

outline of the waveform. Where there are pauses there are straight lines and where syllables are stressed, more loudness. Vowels tend be louder, so frequencies in fricatives are irregular while vowels are neater as some sounds are regular, others irregular.

In the sample ‘My voice,’ there is a nasal + vowel (m + y) followed by a voiced fricative+ vowel and voiceless fricative (v+ oi+ ce.) Despite the apparent lack of articular movement, some of the essential elements of speech sounds are preserved in order for listeners to perceive meaning. For example, the participant must be moving the velum (by raising or lowering) to achieve nasals.

5.8. Energy

In comparing the SV and whispered samples, some similarities in frequency and energy distribution are evident. Clearly, there is energy in both waveforms, represented by the darker areas, the darkest areas having higher density energy, while the lower energy densities appear lighter. In normative speech, voiceless sounds have more energy than voiced sounds because there is an aperiodic component that introduces a random nature to these sounds (plosives fricatives and affricates) because they are sounds that constrict the airstream. In contrast, voiced sounds like vowels, nasals and approximants do not obstruct the airstream so are very resonant, giving rise to a more regular wave visible as darker areas on the trace.

During recording, the screen offers two views of the on-going waves and troughs that

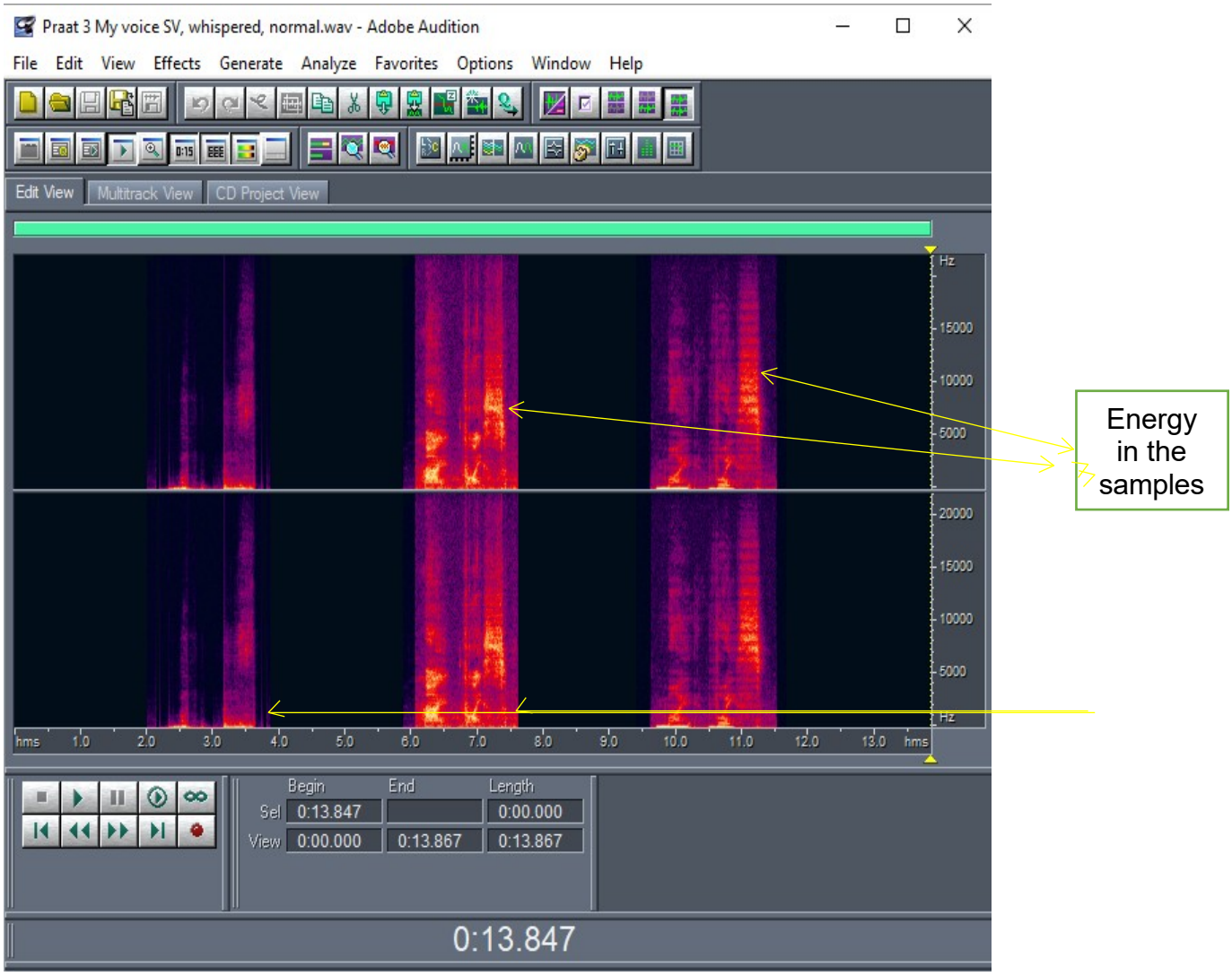
represent the acoustic trace. Accessed via the ‘View’ tab on the toolbar, the Waveform

view displays the contours of the waveforms as they occur. The Spectral View highlights specific frequency areas to facilitate analysis of editing. In a coloured trace the energy is displayed in the lighter areas.

Figure 5.4. below shows a spectral view of the frequencies or energy in the three different samples, displayed on the Adobe Audition screen. The lack of energy is very obvious in the SV sample in Figure 5.4. below, in comparison to the researcher's whispered and spoken samples where energy in the form of the lighter yellow/orange areas can be clearly seen. The degree of energy apparent in an utterance has some implications for listener perception of speech sounds according to Moore et al (2010) and Monson et al (2011) and intelligibility (Moore 2010) who report that high frequency energy (HFE) is more significant in perception than previously recognised. Hartl et al (2003) also report HFE as having positive implications for perception in voice disorders, suggesting the benefits of further examination (at a later date) of the energy in SV utterances.

The spectral images below include a range of features in addition to formants. The use of Pratt software enables visual comparison between the researcher's samples and the participants' samples, providing evidence of the similarities and differences.

Figure 5.4: Spectrogram of the frequencies or energy in the samples

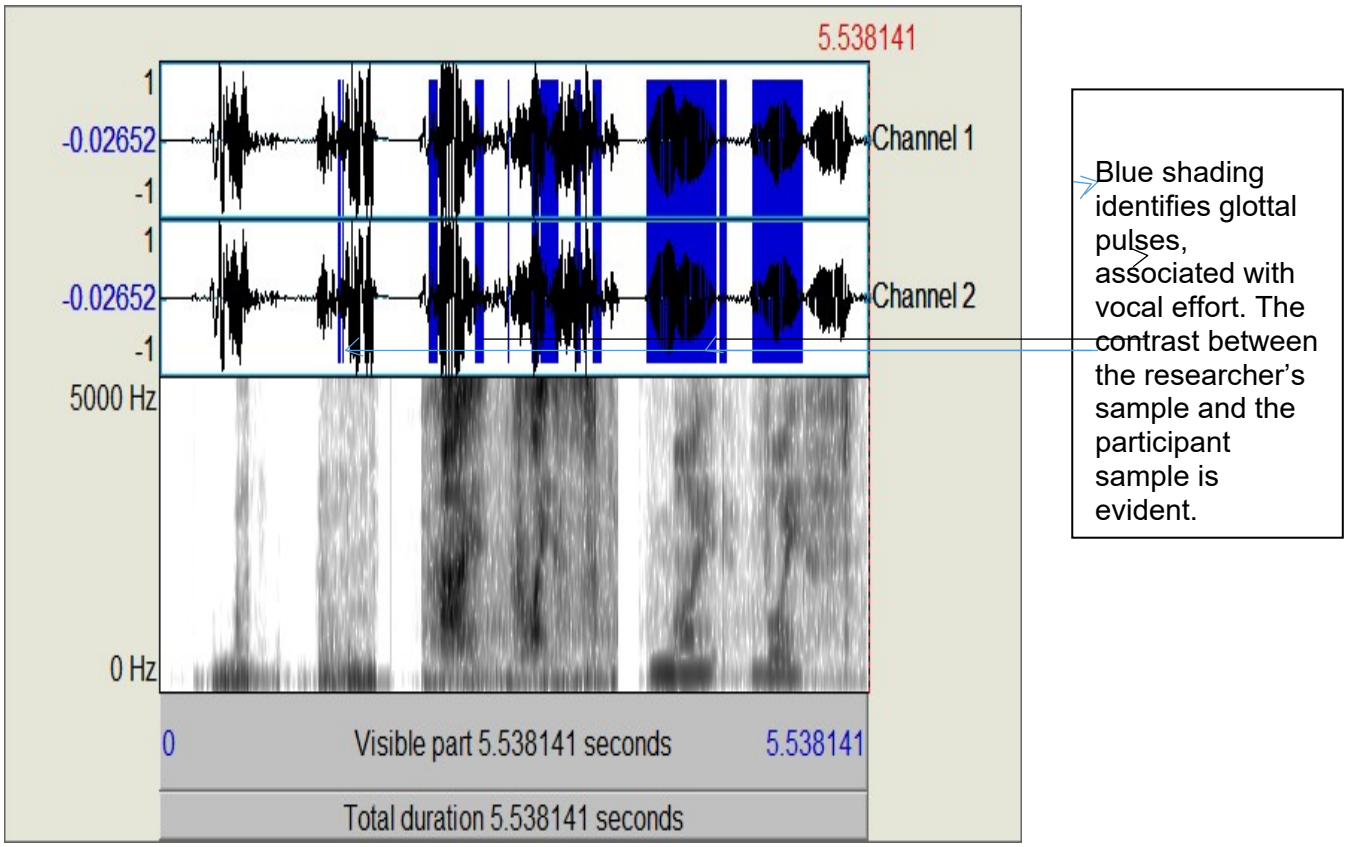


5.9. Pulses

A glottal pulse represents one opening-closing cycle of the vocal folds. In contrast to whisper, the vibration of the vocal folds occurs as air flows through the glottis introducing a periodic component in voiced vowels. This increases the loudness of voice sounds in relation to vocal effort. Praat displays pulses as bright blue vertical lines on the waveform in the upper half of the spectrogram, marking where Praat has detected a glottal pulse. There is a significant difference in the pulses between these samples, clearly indicating pulses in the researcher samples, in comparison with the

very limited evidence of glottal pulse in the participant sample. The vocal effort by the participant is significantly less than that of the researcher.

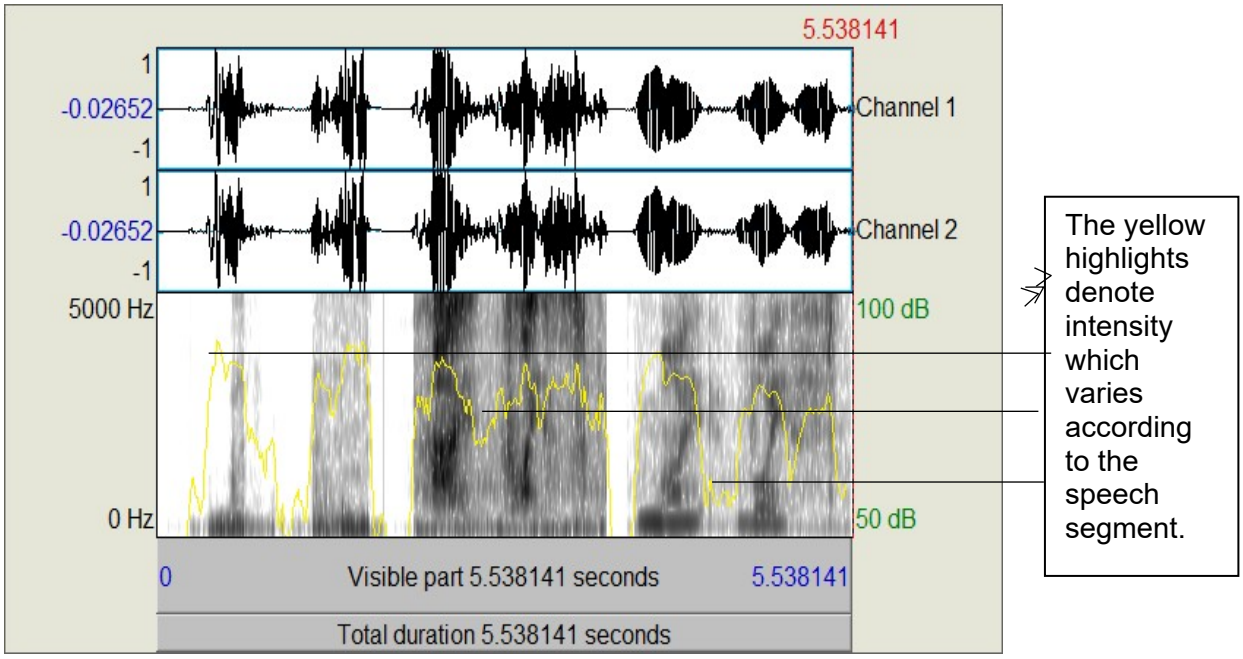
Figure 5.5. Spectrogram displaying glottal pulses.



5.10. Intensity

Intensity is displayed as yellow lines in the spectrogram in Figure 5.6 and relates to sound pressure as a measure of the slight variations in air pressure that the listener perceives as sound, becoming louder with increased pressure. Like amplitude, intensity is not a distinguishing feature of the sound wave. However, it can be seen in Figure 5.6. that the participant's sample is similar to that of the researcher.

Figure 5.6. Spectrogram displaying intensity



This is because it has been amplified (30 dB) so is artificially manipulated to be audible. In Figure 5.7. below showing waveforms and intensity, the participant's sample is not amplified and the lack of sound pressure in comparison to the researcher's whisper and spoken samples is very evident. This figure also displays the participant's original waveform, before amplification, and the contrast with the waveform for the researcher samples is very marked.

Figure 5.7. Spectrogram of waveforms and intensity (participant sample not amplified)

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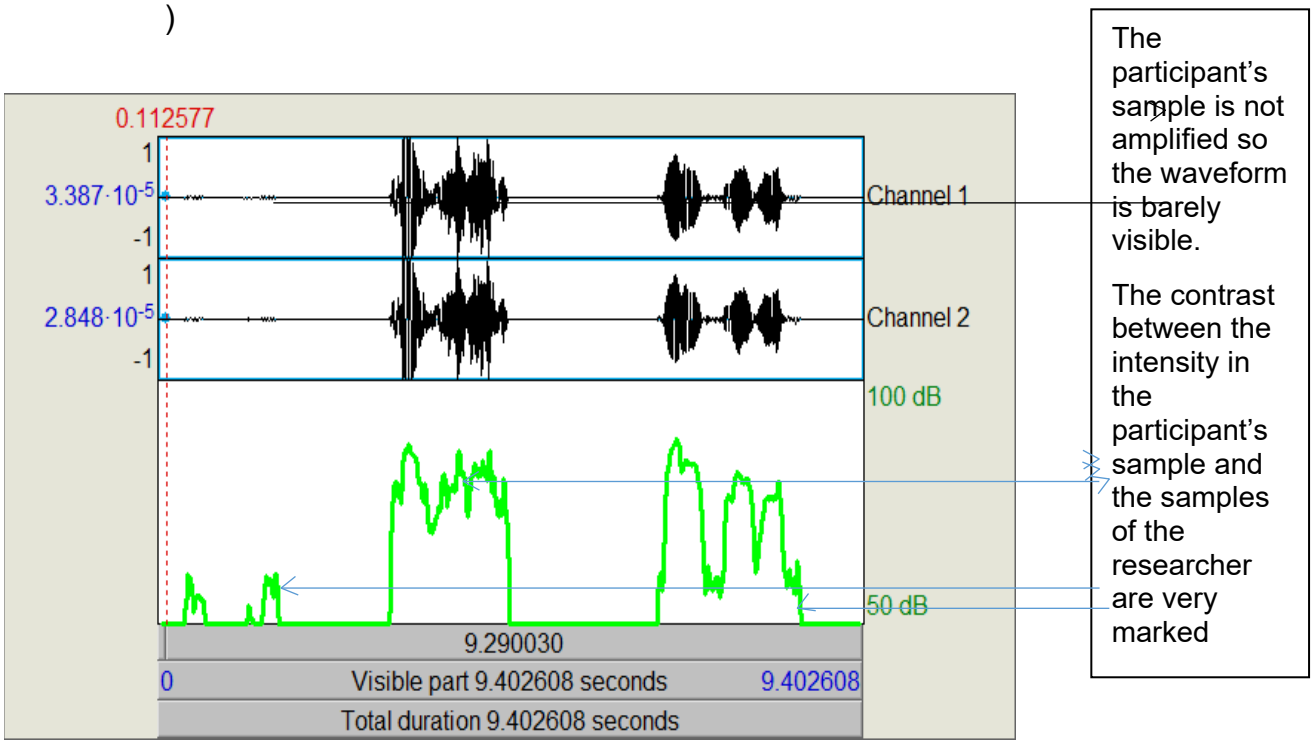
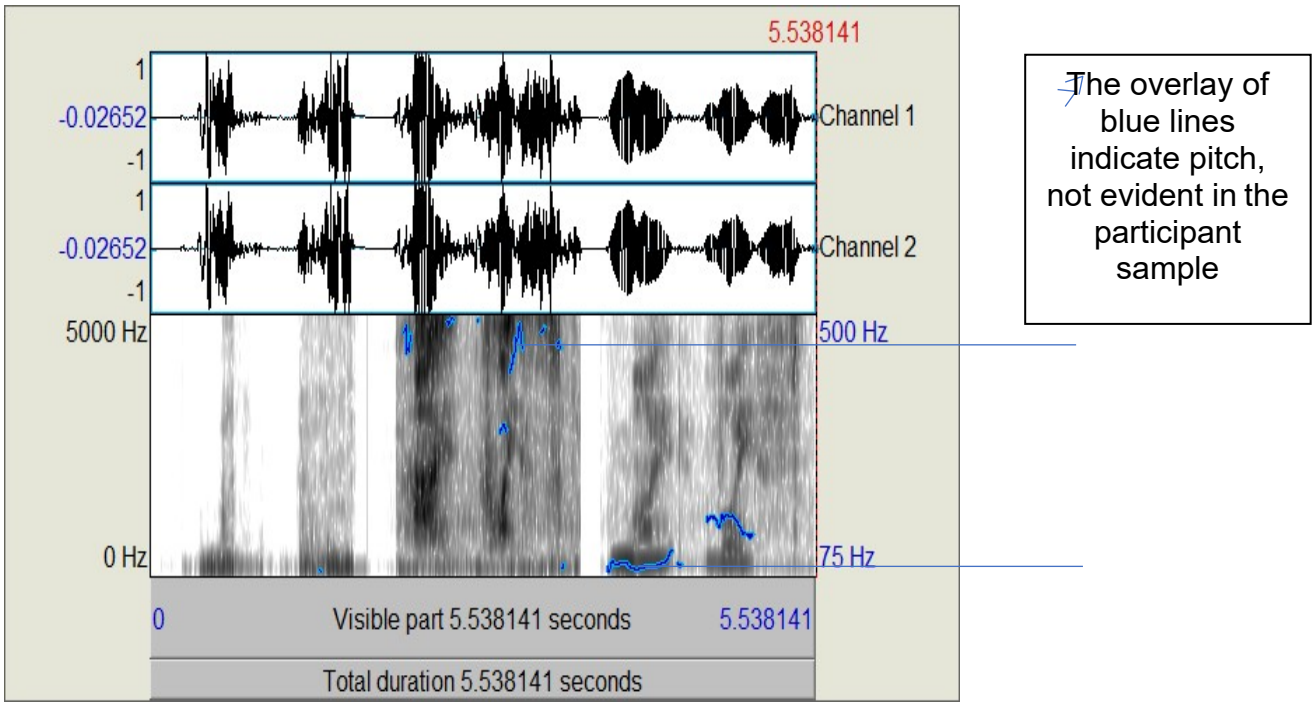


5.11. Pitch

Figure 5.8. Spectrogram displaying pitch



In Figure 5.8. above, pitch is displayed on the spectrogram as a blue overlay of small, blue lines, indicating the changes in frequency as pitch rises or falls. Ashby and Maidment (2005) define pitch in relation to the openings and closings of the vocal cords, producing sound also known as fundamental frequency. Vocal pitch is derived from the characteristics of the vocal muscles where their tension and the flow of air will produce higher or lower vocal pitch. Higher pitch is induced by greater frequency of opening and closing with less thickness and greater tension in the vocal chords. In contrast, thicker vocal cords, less tension and reduced opening and closing lowers vocal pitch. Thus, pitch correlates with vocal fold tension and vocal tract shape but without vocal fold vibration, pitch variation is difficult to determine. In whispered speech, perception of pitch relies on the resonances in the front of the mouth. If that area is reduced, for example if the tongue moves forward and rises towards the palate /i/ the frequency increases and pitch rises. In Figure 5.8. above, although there will be pitch it will not be evident. The variation is only an indicator of voiceless speech and is not a reliable feature in this context. Pitch is related to frequency of vibration, further indicating that the participant is not producing voiced phonation with vocal fold vibration.

Chapter 5 a sample

Participant 11 : Talking back. Oh Christ!

Participant 13 : Oh Wow! My voice.

Moreover, movement of the lips has implications for pitch, by changing the resonant

frequency in relation to the escape of air through the shape of the lips, as described by Ashby and Maidment (2005.) As already noted above, SV phonation appears to occur without discernible movement of the primary articulators, and the absence of pitch related to lip shape adds weight to this assumption. However, although there is no voicing, pitch can be present, as with whispers and shown on the researcher's whispered sample, which can be produced in higher or lower pitch. Ashby and Maidment (2005) note that intonation uses changes in pitch of the voice to facilitate interpretation of utterances, so that the delivery of an utterance may carry information about the speaker's intent capturing for example, anger, excitement or disbe- lief by the way in which the utterance is emitted. Pitch used in this way is evident in SV utterances, where participants exclaim, demonstrating their ability to use pitch appropriately as in the audio sample above.

5.12. Difficulties in the analysis and comparison of samples

Study 1 was designed to identify and demonstrate an appropriate analytical instrument and method for the analysis and comparison of SV utterances with normative speech and whispers. Although Praat was identified as a suitable tool for analysis, some difficulties in the procedure must be acknowledged. Examination of the participant SV samples, either individually or between participants, could be problematic. As reported previously, integral ambient noise and poor quality on SV samples could obscure and distort utterances, introducing confounding factors that made analysis challenging. Moreover, the likelihood that participants achieved articulatory targets in differing ways to that of the researcher or to each other was an added variable potentially detracting from consistency in SV samples. The data could not be standardised. In addition, the use of Praat, where samples were cropped for analysis, results in expansion to fit the

window, making ostensibly similar stimuli look very different. Consequently, the comparison of participant utterances with normal speech and whisper samples, while offering the means to compare acoustic phonetic similarities between SV utterances and normal whispers and spoken speech, was not without difficulties. The limitations of this approach must be recognised. Acoustic analysis demonstrated in this study offers an indication of how such analysis can be used to investigate utterances as a physical ‘speech like’ event but in this study, outcomes cannot be validated at this stage. Further and more extensive research is necessary.

5.13. Dysarthria

The use of Praat software to identify the presence of acoustic and phonetic features in participant SV utterances raised queries regarding the inability of participants to produce audible, phonated utterances. Audible vocalisations in response to comments by the researcher should have been meaningful in view of their ability to produce SV meaningful utterances as responses. However, where responses were audible, they presented as disordered. A link with dysarthria seemed possible. Distorted and disordered audible vocalisations were very common in participants yet SV utterances were most frequently far less disordered. Participant 1 typifies this, producing audible utterances that are severely dysarthric yet SV utterances that are far less disordered. Below, the first sample is a dysarthric utterance (content unknown) by Participant 1, the second is an SV utterance that can be transcribed.

Chapter 5 b

Participant 1 : Audible dysarthric utterance

Participant 1: SV utterance ‘Beware the man, he speaks’

Due to the significant difference between the audible dysarthric vocalisations and the SV utterances produced by participants, dysarthric vocalisations were examined and analysed (using the same computer software) following Rudzicz (2011) who demonstrates that certain problems of intelligibility in dysarthria can be identified and corrected acoustically. The possibility that distorted vocalisations produced by participants designated PMLD may have some linguistic meaning has not been explored, due to the assumption that this population is pre-linguistic and language is therefore not anticipated. Nevertheless, recordings of such vocalisations, adjusted for pitch, did demonstrate intended meaning. See the audio samples below where Participant 16 says audibly, ‘I’m nervous.’ Initially the sample appears to be dysarthric. The sample was adjusted acoustically to produce a clearer version of the phrase, ‘I’m nervous.’ The utterance was manipulated via the ‘Effects’ function. This was employed to access the Time/Pitch function to set the Stretching Mode at Pitch Shift, using the gliders or pre-sets. The participant confirmed the intended phrase in both the dysarthric and adapted form. Although the adjusted version still lacks the precise clarity of normal speech, there is some degree of improvement, better demonstrating the intention of Participant 16 to use meaningful language.

Chapter 5 c Sample

Participant 16: Dysarthric: I'm nervous.

Participant 16: Adjusted: I'm nervous

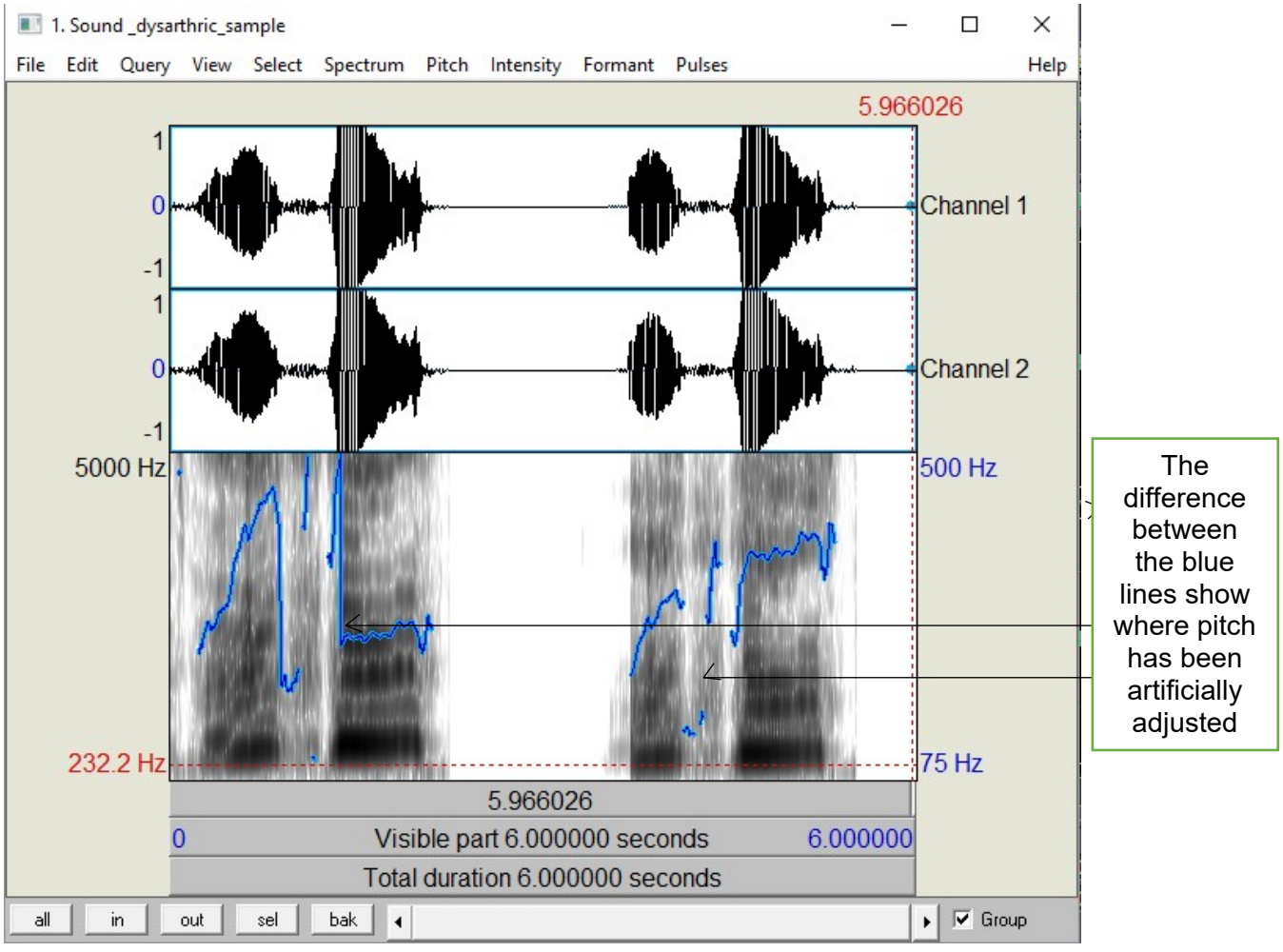
Figure 5.9 below shows the difference between the dysarthric and the adjusted samples of 'I'm nervous.' Although vocal dysarthric recordings by participants could be adjusted in this way, the procedure offers variable degrees of intelligibility and is very time consuming. It is often the case that every syllable in a dysarthric utterance requires adjustment to achieve any degree of clarity. In contrast, SV utterances did not appear to be disordered to the extreme extent evident in dysarthric efforts and were therefore more easily transcribed.

Severe dysarthria is commonly characterised by a continuous stream of voiced vowel sounds with few if any perceived pressure consonants. Such consonants require significant muscular effort to produce constriction of the airstream through the vocal tract and this is commonly weak in severe dysarthria. As a consequence of the nature of the muscular weakness and difficulty controlling timing and airstream, the resulting speech pattern is therefore distorted and frequently unintelligible to listeners

Although the disordered vocalisations of participants were investigated, this approach, as with the acoustic analysis reported above, must be acknowledged as having limitations due to the lack of standardised data in the form of participant samples.

Nevertheless, as with the acoustic analysis of SV utterances, it offers a means to explore and describe some of the features in the vocalisations produced by individuals designated PMLD, to promote further and more extensive research into their potential linguistic abilities both dysarthric and sub vocal.

Figure 5.9. Spectrogram of 'I'm nervous,' dysarthric and adjusted



Dysarthric Dysarthric adjusted

The first representation on the spectrogram is the unintelligible dysarthric sample, the

second representation is the adjusted sample.

Although dysarthric vocalisations appeared to be present in most participants, sub vocal production, like whispers, require less muscular effort and less respiratory effort. This perhaps facilitates more precise and controlled production, albeit inaudible and requiring amplification. Most participants, once aware that they could ‘talk’ asked to learn to do so ‘out loud.’ but audible efforts were invariably distorted, lending weight to the possibility that dysarthria distorted intended audible speech sounds, in ways that were far less significant for SV phonation. Sub vocal utterances could operate where audible efforts were unintentionally dysarthric. The presence of dysarthria, producing unintelligible distorted sounds in contrast to intelligible SV utterances suggest that participants made efforts to ‘speak’ audibly that remained unrecognised, not only due to the distorted nature of the phonation, but also due to the assumption by listeners that individuals designated PMLD lacked linguistic competence. Thus, vocal efforts were presumed to be meaningless.

5.14. Signal entropy and spectral flatness analysis

As well as the examination and comparison of the acoustic and phonetic properties in SV utterances and normal phonation, an additional means of analysing samples was identified. Signal entropy and spectral flatness offered a means to ascertain properties in the samples that distinguished them from meaningless noise. Collaborative work was undertaken with Dr.David Kerr at Loughborough University (Woods, Cornelius and Kerr, 2019, in preparation) to analyse the SV samples for entropy and Spectral Flatness. This measures the structure of the spectrum produced by the signal so that white or meaningless noise lacks structure while a fundamental note and the

accompanying natural harmonics produce a highly structured spectrum. Thus, spectral flatness indicates acoustic activity (Madhu 2009) such that the statistical disorder of the signal is represented as spectral entropy, showing a higher amount of order (lower entropy) where the measured noise is purposeful in comparison to a signal produced by random noise. A signal showing lower entropy may be associated with the ordered sounds occurring in the signal produced by the SV utterance, while meaningless noise presents as a disordered structure. Using this approach, a range of recordings was analysed, consisting of normal speech samples and sub vocal speech by the participants, containing short pauses or periods of silence to act as a comparator. Results identified that order was apparent in those parts of the samples containing utterances, identifying that the signal was not meaningless noise.

See Appendix XVI: Signal Entropy and Spectral Flatness analysis

5.15. Phase 1 Summary

Phase 1 identified the means to analyse SV utterances for comparison with normal whispered and spoken versions of the same phrase by the researcher. Using Praat to investigate acoustic and phonetic characteristics of utterances, in conjunction with Signal Entropy and Spectral Flatness analysis, a range of utterances could be similarly investigated. Spectrograms displayed acoustic energy in the same frequencies in the participant SV samples as seen in the whispered and spoken samples of the researcher. The production of vowels was highlighted. The relationship of mouth shape to vowels sounds was evident where observed formants identified the presence of vowels, incorporating the features also evident in the matched samples of the researcher. The participant samples were shown to have features of normal speech but produced atypically. Parallels between normative speech and sub vocal phonation

by PMLD participants were indicated, incorporating features and characteristics recognised as integral to normal speech and whispers despite the atypical nature of their production. The limitations in this approach were apparent, as described above, such that outcomes could not be fully validated in these conditions. However, the means and the potential for further investigation and analysis of utterances within this framework were established.

CHAPTER 6: **PHASE 2**

Introduction

Phase 2 addressed the research question:

Are the SV utterances intelligible such that familiar and naïve listeners would be able to understand the amplified samples?

Phase 2 used samples of SV utterances produced by the 20 research participants to assess the ability of listeners to perceive them as intelligible. Samples were selected for the best acoustic quality of the digital recordings.

The hypothesis that individuals designated PMLD could produce meaningful SV utterances intelligible to listeners necessitated an examination of the degree to which listeners could correctly perceive the content as intelligible. The identification of characteristics common to both SV utterances and normal speech and whispers in Study 1 indicated the ‘speech like’ nature of utterances but the extent to which this facilitated intelligibility was unclear. Consequently, the need to explore the intelligibility

of SV utterances was apparent using a quantitative methodology to implement a series of listener tests of intelligibility. This chapter presents the procedures used to assess the intelligibility by 40 listeners of a range of SV utterances by 20 participants designated PMLD. It presents the reasons for the procedures and protocols employed, and details the listener tests of intelligibility and the subsequent outcomes.

6.1. The aim of Phase 2

The aim of phase 2 was to test the intelligibility of SV utterances produced by the research participants. In order to do so, the study was designed to carry out a range of listener tests of intelligibility in open and closed conditions. This would enable the collection of data on listener percentage intelligibility and identify the influence of different variables on listener intelligibility. This chapter is divided into two sections.

Section 1 presents the rationale for examining the intelligibility of utterances and details the subsequent development, design and implementation of the listener tests.

Section 2 presents the results of the listener tests, including the statistical measures used, followed by a discussion of the outcomes and the implications for the research.

SECTION 1

6.2. Rationale for the listener tests

Côté (2011) defines speech intelligibility in terms of the extent to which a message has been retrieved from the recognized phonemes (the smallest units of speech). Similarly, Viswanathan and Viswanathan (2005) define intelligibility as the extent to which words and sentences can be understood. The measured extent to which listeners could

understand SV utterances provided an indication of the degree to which listeners could indeed perceive SV speech as intelligible and meaningful. As stated earlier, authorities and researchers consider PMLD individuals to be pre-linguistic and pre-intentional communicators, operating only by the ability of their partner to attribute communicative significance to their actions and behaviours. In contrast, the ability of the research participants to use SV language, and the ability of listeners to perceive utterances as intelligible could signify that real words were present and meaning was not conferred on the participant, but was instead integral to their SV language.

An additional reason for the use of listener tests of intelligibility by participants pertained to communication. The PMLD population is characterised by their inability to make use of a range of communication interventions that founder due to their sensory and physical impairments, limiting and restricting their efforts. In this research, demonstration of the presence of meaningful utterances, if shown to be there, clearly had implications for communication. The use of listeners in intelligibility tests of SV utterances was intended to be reflective of real life situations, with potentially relevant outcomes for the communication needs of people designated PMLD.

The review of intelligibility studies in the literature provided guidelines for listener tests of intelligibility, including the strengths and limitations of varied research methodologies. However, the range of variables within studies, and the difficulties in establishing a definitive concept of intelligibility made many research outcomes specific rather than general. Moreover, intelligibility studies commonly explore speaker attributes but, in this study,, the ability of participants to ‘speak’ SV utterances could not be explored due to the lack of verbal phonation and the current lack of research

into this previously unrecognised phenomenon. Nevertheless, reference to existing studies in intelligibility encompass the role of the listener, particularly with regard to dysarthric speech, offering a template against which to establish the framework for listener tests.

Research findings regarding the role of the listener have been significant in relating listener attributes to intelligibility. Due to the novelty of the phenomenon under investigation, the influence of listener characteristics on the intelligibility of SV utterances produced by individuals designated PMLD is entirely unknown, necessitating an exploration of the interface between SV utterances and listener perception

6.3. Pilot Listener Test

In order to ensure a suitable design for the listener tests, a pilot test was formulated to trial the intended test format, test protocols and means of data collection, prior to the introduction of the formal listener tests of intelligibility.

6.4. Rationale for the Pilot Listener Test

The pilot test used a small number of volunteer participants to establish a body of information about the ability or otherwise of listeners to rate and make judgments about SV utterances. See Appendix XVII: Pilot listener tests. The pilot was designed to trial the intended procedures for the authentic listener tests and identify potential difficulties in gathering relevant data accumulated from the tests. The selection of appropriate statistics for the presentation of relevant data was also required and outcomes of the pilot test would contribute to the appropriate choice. In addition, it was anticipated that

responses from the listeners in the pilot test would identify the appropriate number of samples to be used and the best methods for presentation of the samples. Responses from listeners in the pilot test were intended to provide a framework for a more extensive data collection, using a cohort of 40 listeners to participate in a range of listener perception tests to rate or judge SV phonation.

The pilot test was also designed to test how best to present, organise and gather relevant data from the intended listener tests. Burrows et al (2001) and Ross-McGill et al (2000) report the advantages of a pilot test in research as a means to establish required procedures and documentation. Prior to the implementation of the tests, practical details in formulating procedures and protocols for the real tests had to be identified. The design of test papers was also a consideration. Carfoot et al (2002) emphasise the importance of piloting the data collection forms to ensure that they will be easily understood and clearly presented, in order that data collection will be consistent and appropriate, as well as easily administered.

Listener results from the pilot test were not intended to be included, analysed or calculated with regard to listener intelligibility, as listener numbers in the pilot test were small and the content of the pilot test differed from that of the subsequent formal tests.

6.5. Procedure for the Pilot Listener Test

The pilot listener test used six listener participants drawn from the Speech and Language Therapy (SaLT) student population at De Montfort University who would not be involved in the main study. Listeners were recruited via written invitation and explanation of the intended study. Listeners were from Years 1, 2 and 3. No listeners

were familiar with SV utterances produced by children and adults designated PMLD.

The test took place in the Speech Laboratories of De Montfort University. The purpose of the test was explained to the listeners as a means to 'test the test.' Thus, although listeners were required to listen to SV samples and write down what they thought they heard, emphasis was upon identifying the most suitable test procedures and documentation. Listeners were encouraged to contribute their ideas and opinions about their listener experience and how best to present samples for maximum listener perception.

6.6. Administering the Pilot Listener Test

Six listeners sat at equidistance from the laptop computer to hear the participant SV samples. They heard 37 SV words in total. The tests were comprised of 12 target words in closed tests and 25 words in open, spontaneous responses to equal 37 SV words in total. Listeners were asked to tick target words for closed tests and orthographically transcribe words in open responses. Test samples were selected by the researcher, extracting samples from participant recordings with the best quality acoustic sound.

6.6.1. Identifying the 'speech like' quality of the samples

In addition to identifying target words, listeners were also asked to rate the sound of 6 SV samples in comparison to normal speech This task did not require identification or transcription of the content of the samples, but only the extent to which it each sample sounded 'normal' in comparison to real speech. Listeners selected from 7 options,

ranging from ‘Normal’ to ‘Never.’ The intended purpose of this test was to establish if samples were ‘speech like’ acoustically and heard as such rather than as simply noise.

6.6.2. Degrees of understanding

A second rating task required listeners to rate their degree of understanding of SV words/phrases when told the content of the sample. Knowing the meaning of the utterances, could listeners hear and understand the content? Listeners selected from 7 options ranging from ‘Understood most words’ to ‘Understood none.’

6.6.3. Listener Questionnaires

At completion of the tests, listeners completed questionnaires to identify the protocol most suited to facilitating test conditions. Responses identified the format of the test papers, the mode of presentation of the samples and the practical conditions in which to conduct the tests.

6.6.4. Findings of the pilot test

Analysis of the data in the pilot test identified the format for the formal tests and identified some necessary post-test adjustments. Some tasks included in the pilot test were discarded. The task requiring listeners to rate samples according to how ‘normal’ they sounded was removed, considered by the listeners to be insufficiently definitive, and very difficult to assess. In addition, after subsequent consideration, the ‘normalcy’ of the sound of a sample was not a relevant consideration in demonstrating the intelligibility or otherwise of SV samples. Similarly, the task requiring listeners to rate their understanding of known SV samples was not included in the formal tests. The

pilot test made apparent the advantages of correct and incorrect identification of the words in utterances, without prior knowledge. Listeners too identified the difficulties in measuring degrees of understanding instead of simply recording a correct or incorrect response. As the pilot test identified that rating tasks were surplus to requirements and difficult for listeners to use, they were not used in the subsequent formal tests.

The pilot test was followed by the formal listener tests. Results of the pilot test provided the format for delivering the formal listener tests, designing the test papers and the most suitable means of collecting the test data.

6.6.5. Developing the formal listener tests

Listener tests were used to assess the ability of listeners to correctly perceive SV utterances in a range of open and closed conditions. Administration of the formal tests followed the protocols identified by the pilot test. See Appendix X1 for all listener test documents.

6.6.6. Test protocols

Samples were played to listeners in a silent room with the maximum of 6 listeners at a time to ensure equidistance from the sound source. Listeners were informed verbally and in writing to tick the target word from response sets for 7 closed tests, and orthographically transcribe words in 3 open sentence tests. Listeners were asked to leave a blank space where they could not understand all or part of the sample utterance/s. Samples were played three times, introduced by ‘Three, two, one’ spoken by the researcher so that the start of the sample could be anticipated.

Listeners participated in closed tests 1- 7 and open Test 8 and Test 8a on the same occasion. Subsequently, Test 9 was conducted separately with some new and different listeners to replace those who had left the establishments over the summer break.

6.6.7. Design of test papers

Resulting from the pilot test, the most suitable design of the test papers to ensure easy yet consistent data collection was found to be grids for closed tests, and separate lines for orthographic transcription for open responses. Separate sheets for each tests were presented, so that test responses were clearly separated, with instructions printed above each test. At completion of tests, listeners were allocated a number to ensure anonymity.

6.6.8. Recruiting listener participants

Pennington and Miller (2007) explored the influence of listener characteristics and listener conditions on the intelligibility of dysarthric speech and reported that listeners of any age or gender could be used for intelligibility tests, providing hearing acuity was established. Consequently, using this criteria, listeners were sought to participant in listener tests of the intelligibility of SV utterances. Respondents were given an information pack, explaining the study and their anticipated contribution to it as a listener. Respondents completed a consent form at the beginning of the test.

40 listeners were recruited in total via a written invitation to participate. The invitations were made available in the educational establishments where the research was undertaken and in other institutions representing varied occupations including

hospitals, college staff, police, farming and administrative posts. Parents of children with special needs were included, designated as ‘Parents’ rather than by occupation. Table 6.1 below shows the listener set according to occupation and gender.

Table 6.1. Listener participants according to occupation and gender

	Male	Female	Total
Parents	2	4	6
Farmer	1	1	2
Police	1	0	1
College Staff	1	2	3
Administrative	0	3	3
Secretary	0	2	2
Nurse	0	2	2
Teacher	3	6	9
Teaching Assistant	2	10	12

As can be seen in the above Table 6.1, teaching assistants were represented more than any other occupation. Their willingness to volunteer may have reflected their availability in institutions attended by people designated PMLD, with less classroom responsibilities than teachers or lecturers. In addition, one staff member responsible for organising the research project with the researcher at one school specifically encouraged her colleagues to contribute.

6.6.9. Naïve and familiar listeners

Following recruitment, listeners were designated as (20) familiar and (20) naïve, for later consideration of familiarity/ naivety as a variable in interpretation of outcomes. This reflected results from a range of intelligibility studies where the influence of

familiarity on the intelligibility of dysarthric or disabled speech has been reported as positive (Borrie et al 2011., Liss, et al., 2002; Liss, et al., 1998.) The potential implications of similar outcomes for SV utterances required consideration of the influence of familiar listeners on intelligibility in comparison with naïve listeners. Consequently, listeners were designated familiar or naïve initially to provide 2 listener sets, with 20 listeners in each set. However, due to the novelty of the phenomenon under investigation, exposure to SV utterances was rare. There were no listeners (other than the researcher) who were experienced listeners. Accordingly, the criteria for familiar listeners was set at 4 minutes of exposure to transcribed SV utterances for listeners who had attended a presentation by the researcher to explain the research study. Naïve listeners were those who had no exposure to SV utterances

.6.7. Presentation of sample utterances

All SV samples for listener tests were presented as digitally recorded data as the impairments and disabilities of the participants precluded any realistic expectation of their attendance during test procedures. Inaudible SV utterances from the best quality digital recordings were selected as samples, then amplified and processed to obtain maximum clarity of each utterance. Letowski (2017) considers that samples for intelligibility tests may be live, synthetic or pre-recorded but must be delivered in a way that reflects the purpose of the assessment. In this research, where access to SV utterances can only be via digitally recorded samples, the same means of presenting samples for intelligibility testing is entirely congruous.

6.7.1. Constructing sample sets

Samples were selected as items for the closed and open tests. The word lists for the

closed tests were based on phonetic and phonological criteria. Two sets were constructed:

- Word sets where items were all very similar phonetically with only subtle differences, making discrimination difficult, and potentially challenging listener perception.

- Word sets where items were all very different phonetically, potentially making discrimination less difficult.

In addition, word sets were constructed to examine the influence on intelligibility of::

- Context
- Experience (all words by the same speaker)
- Number of syllables on intelligibility.
- Naivety and familiarity

In open tests, samples were constructed to explore the influence on intelligibility of:

- Contiguous utterances
- Context
- Length of utterance.
- Naivety and familiarity

In constructing word sets, the visual impairments and respiratory limitations of the

participants made measures commonly used in orthographic transcription tasks unrealistic. Participants could not record reading passages or monologues or produce extensive checklists of required words of sufficient (recorded) quality to ensure standardisation. It was therefore necessary to produce SV samples over an extended number of sessions, rather than recorded on one occasion.

Although the word pool was constructed to explore a range of variables as described above, some consideration was also given to the quality of recordings. Participants demonstrated differences in their SV phonation both within and between individuals, therefore producing variable outcomes. In addition, the quality of recordings varied due to technological effects, to the detriment of some samples. Consequently, the final choice of samples reflected a compromise between best quality recordings and the choice of items for required word sets

The majority of samples were drawn from the entire pool of digitally recorded data, rather than created to meet pre-determined specifications. Thus, due to the difficulties associated with the range of impairments that characterised the participants, and the resultant variables in association with the difficulties in recording participants, samples were extracted from the wide variety of recordings from different participants and not specifically created. Different classes of utterance were then collated. Some single words were obtained by inviting participants to say those individual words (Please say ‘elephant,’) or by extracting single words used spontaneously by participants in single word or sentence utterances. Some words were produced in imitation/copy of words spoken by the researcher (colours and animals) and where this occurred, some regard must be given to the reported outcome of higher intelligibility scores where imitation is

used rather than reading tasks for speakers. (Yorkston and Beukelman 1984). As participants have neither the reading skills nor the visual acuity to read words or sentences, imitation of some words spoken first by the researcher was necessary. The researcher's own voice was deleted from the samples prior to listener tests. Subsequently, copied words were examined for percentage intelligibility in comparison with words that were not copied, in order to compare if imitated samples had a positive association with intelligibility.

NB: Procedures, equipment and software used for recording samples are itemized in Chapter 4, Methods (4.15. Recording methods) .

6.8. Listener tests

Closed and open tests

The listener tests were comprised of 7 closed tests and 3 open tests for a total of 10 tests of listener intelligibility

6.8.1. Closed tests

Closed tests were constructed to collect data on the ability of listeners to perceive single SV words as intelligible. A closed test provides the listener with a range of options from which a choice is made. Listeners were required to identify 42 single target words from a word pool of 77 words, given in closed response sets. Thus, 40 listeners heard 42 words to total 1680 words overall for all closed tests.

6.8.2. Rationale for closed tests

The closed tests used single word utterances to provide data on the influence of a number of phonetic variables that are considered significant for perceptual processing of speech. Hawkins (2003) reports that the perceptual processing of phonetic information functions to identify features or phonemes that enable the listener to distinguish words. There is structure to the sounds of language, comprised of units such as phonemes, syllables and words. By concentrating on different units encompassed in the single words selected for the closed listener tests, the relationship between listener intelligibility and the word structure could be explored. A sound in a word is dependent on a range of factors including the adjacent phonetic context and the position it occupies within words. The extent to which individuals sounds were present in different word positions and phonetic contexts of SV utterances could have implications for intelligibility. At its most basic, were phonetic and syllabic variables more or less intelligible to listeners? Significantly, phonetic information is especially important in ad- verse listening conditions (Hawkins 2003, +2the quality of recordings of SV utterances impinged on clarity. Moreover, current research indicates that phonetic information is an important aspect of speech processing, reflecting the function and structure of the small units of which words are made (Nguyen 2009.) The ability of listeners to perceive phonetic and syllabic differences (and therefore facilitate intelligibility) could also con- firm the presence of such features in the utterances, further reinforcing the proposal that the utterances are indeed real words made up of real speech sounds.

The choice of words in the closed tests 1-7 were chosen to include different phonetic speech sounds and a range of syllable positions. As identified in Table 6.2 and Table 6.3 below, the word pool for each test represented different phonetic variables be-

lieved to impinge upon intelligibility as described above (Howard et al. 2008) and requiring different listener qualities. Thus, the words for each closed test were selected to assess listener intelligibility in response to variations in phonetic, phonemic and syllabic structure in different word sets.

Table 6.2: Listener attributes examined in each closed test.

Test	Test Description
1	Requires listeners to differentiate phonemic differences ranging from near minimal to maximally distinct sets
2	Requires listeners to differentiate phonemic differences ranging from near minimal to maximally distinct sets
3	Assessed the influence of the number of syllables and word length on listener intelligi- bility for 10 target words
4	Assessed phonemic contrasts for the influence of distinct phonetic differences on lis- tener intelligibility for 6 target words
5	Assessed the influence of semantic context (colour) on listener intelligibility for 5 target words
6	Assessed the influence of semantic context (animals) on listener intelligibility for 5 tar- get words
7	Assessed the influence of perceptual experience (all 6 words by the same speaker) on listener intelligibility for 6 target words

Table 6.3. The phonetic and syllabic word structure represented in closed tests 1-7

Test 1: Questions a-e

Test	Reason for word choice	Options

1a	A near minimal set. All mono- syllabic, phonemically dissim- ilar, with phonetic similarities. Same vowels (e) are represented throughout. All start with /s/ and end with voiceless plosives. A combination of singleton consonants at the beginning of the word and consonant clusters.	Speak (Target Word)	seek	squeak	steep	streak	sleep
1b	All monosyllabic words with some differing vowels. Onset and coda are mostly voiceless plosives. Not a minimal set	box	toe	Dad (Target Word)	pat	lip	cot
1c	All bi-syllabic ending with pro- gressive verb form 'ing.' The (1st) stressed syllable is per- ceptually most prominent. Almost all maximally distinct	running	nothing	talking	Some- thing (Target Word)	living	making
1d	All maximally distinct, all bi- syllabic. First syllable most prominent	special	awk- ward	every	rabbit	bed- time	perfect (Target word)
1e	All maximally distinct, all bi- syllabic. 1st syllable most prominent. With 'late' as mon- osyllabic word and 'lucky' as bi- syllabic. Both beginning with the same sound with 'late' as a foil for the target word 'lucky'	often	Lucky (Target Word)	late	today	saving	mostly

Tests 2 - 7

Test		Options				
Test 2	All CVC words (consonants and vowels.) to assess influ- ence of CVC on listener	yes	bus	dad	mum	sit

	per- ception.						
Tes t 3	Range of monosyllabic, bi- syllabic and tri-syllabic words to assess the Influence of number of syllables and word length	1 Budgi e Doggi e	2 Everyo ne Medicin e	3 Purpl e Yello w	4 Ye s No	5 Bett er Tiger	
		6 Sai d Tol d	7 Elepha nt Fabulo us	8 Right Wron g	9 Wint er Sum- mer	10 Brillia nt Marve l- lous	
Tes t 4	Distinct phonetic and phone- mic differences in monosyl- labic and bi-syllabic words	home	father	Chris t- mas	super	care	Private
Tes t 5	The influence of semantic context – colour	blue	yellow	red	or- ang e	purple	
Tes t 6	The influence of semantic context – animals	fox	sheep	pig	rat	turkey	
Tes t 7	Perceptual gains with experi- ence – all words by the same speaker	stop	happy	myself	Sorry	dream	listen

6.8.3 Word pool in closed tests

The total number of words heard by 40 listeners in the closed tests 1 -7 were 1680

Table 6.4. below identifies the word pool and number of target words per closed test

Table 6.4. The word pool and the number of single words in closed tests 1-7

Test	Word Pool	Target Words	Listeners	Total Words Tested
1	30	5	40	200
2	5	5	40	200
3	20	10	40	400
4	6	6	40	240
5	5	5	40	200

6	5	5	40	200
7	6	6	40	240
				1680

6.9.Data collection

Data collection in both closed and open tests focussed upon listener intelligibility of SV utterances as both single and contiguous words. Essentially, the tests were intended to measure the number of words that listeners could retrieve from utterances in closed and open conditions. However, in addition to this objective, data was also collated to provide additional information on the influence of different conditions upon intelligibility outcomes.

6.9.1. Data collection in closed tests

Data collected in closed tests comprised:

- Percentage intelligibility - the number of words correctly identified as a percentage.
- The influence of naivety and familiarity on listener intelligibility — comparison between outcomes for familiar and naïve listeners
- The influence of phonetic and syllabic structure of SV words on intelligibility – the extent to which listeners correctly perceived SV words with varied phonetic and syllabic structure (Table 6.2.above)
- The influence of listener experience of intelligibility (all words by the same speaker.)

6.10. Open tests

6.10.1 Rationale for open tests

Open tests are acknowledged as a means to represent real life impairment with maximum face validity (Millar 2006) with potential implications for the use of SV utterances for communication. Additionally, Clopper et al (2006) propose that word recognition in closed tests may not be a valid means to assess word recognition skills. However, although this is a commonly used method, the additional measure of intelligibility in open conditions was seen as complementary to outcomes in closed conditions. Moreover, the closed tests were comprised of single words and the addition of contiguous words in open conditions offered a valuable means to explore intelligibility of both forms of SV utterances. The use of connected words offered a more comprehensive measure of intelligibility, in comparison with the limitation of single words only. Further, the use of contiguous words offered the opportunity to consider listener ability to transcribe utterances of varied lengths.

Open tests were therefore constructed providing data on listener ability to perceive meaning in both single and contiguous words in order to explore if listeners understood the SV utterances in both conditions. Unlike the closed tests where limited options were presented, responses to open tests were entirely the prerogative of the listeners who were informed that all or part of the sample response should be transcribed if understood.

6.10.2. Constructing open tests

Three open tests included a word pool of 77 words heard by 40 listeners to equal 3080 words heard.

Test 8, Test 8a and Test 9 contained single words and contiguous utterances in response sets from 1 -5 words in length. The maximum number or words in contiguous samples was limited to five, reflecting the difficulties in obtaining samples where sufficient respiratory energy was available to maintain longer utterances of sufficient clarity.

6.10.3. Test 8

Test 8 presented 6 single words and 2 contiguous words in 7 response sets x 40 listeners to equal 320 words heard. The utterances were presented as responses to questions or comments by the researcher. Thus, responses were contextually derived, offering sign posts to perception. In order to ensure that listeners understood the anticipated response, rather than guessed it by the context, listeners were clearly instructed to transcribe the response only if it could be perceived. A response should not be transcribed unless actually heard and understood. In addition, listeners were informed that responses by participants were not necessarily correct so that, even if listeners anticipated the SV response, the participant's response could not be guaranteed.

6.10.4. Test 8a

The second open test (Test 8a) presented 7 utterances from 1-5 words in length introducing listeners to connected words for which they had no prior experience. Most contiguous utterances were responses to comments or questions by the researcher. This tested listener intelligibility of contiguous utterances using a word pool of 21 words

heard by 40 listeners to equal 840 words heard.

6.10.5. Test 9

The third open test presented 20 utterances from 1-4 words in length, responses to 4 of which included contextual cues. This test included 48 words heard by 40 listeners to equal 1920 words heard.

Table 6.5 identifies the number of utterances per test and the number of words per utterance for open tests 8, 8a and 9.

Table 6.5: The number of utterances per test and the number of words per utterance for the three open tests 8, 8a and 9

Test No	Number of Response words	Number of Questions	Total Words in test
8	1	6	8
	2	1	
8a	1	1	21
	2	1	
	3	3	
	4	1	
	5	1	
9	1	5	48
	2	4	
	3	9	
	4	2	
Total number of words for all open tests			77
Total number of words heard by 40 listeners			3080

6.10.6 Data collection in open tests

The total number of words (77) in open tests heard by 40 listeners was 3080. Listeners orthographically transcribed the single and contiguous words heard.

Data collected in open tests comprised

- Percentage intelligibility - the number of words correctly identified by listeners as a percentage.

- The influence of naivety and familiarity on listener intelligibility –comparison between outcomes for familiar and naïve listeners

- Correlation between length of utterance and listener intelligibility.

6.11. Scoring the listener tests of intelligibility

In order to ensure objective and valid scores for test outcomes, consistency in scoring was required. Perceptual tests of intelligibility can use a variety of speech units including phonemes, syllables, words, phrases, sentences or paragraphs. In this research, the word is the unit used, both in single and contiguous utterances, measuring correctly understood speech items quantified as the percentage of speech material recognized. Schiavetti (1992) acknowledges the advantages of using a word identification as a measure of speech intelligibility that is calculated as a percentage of correctly recognised words. Variability in measures of intelligibility are not uncommon (Keintz et al., 2007, Hustad, 2006., Bunton et al., 2001) but where objective measures use the percentage of words that are understood correctly , calculated by listener transcription, or where listeners identify the target word from a closed list, outcomes can be acknowledged as valid and reliable (Millar 2013, Pennington et al 2010., Hustad, 2006) Such approaches have been employed in dysarthric research and with children with cerebral palsy, thus offering recognised measures for

calculating listener scores of intelligibility.

For this research, listeners ticked or transcribed the target word from response sets for 7 closed tests, and orthographically transcribed single and contiguous words in 3 open sentence tests. The numerical score for each listener was the number of words correctly identified.

The percentage intelligibility of the samples was calculated where words were scored 1 for correct identification of the target word and 0 for incorrect identification of the target word.

On open Tests 8a and 9, to ensure scoring consistency, where words were contracted ('I'm' and 'she's' for example), initially contractions were treated as one word and scored as such. However, due to inconsistences in transcription, where it was not clear if listeners heard two words and wrote a contraction, or heard a contraction and wrote two words, the data set was calculated using all contractions as 2 words. Thus, 'I'm' and 'can't' would score 2 points as did 'I am,' and 'can not.' This enabled utterances to be consistently scored where listeners might have transcribed either the contracted or the full version.

The total number of words correctly identified provided the measure of percentage intelligibility per listener, per test and over all tests. Each word was scored using the coding criteria presented by Liss et al (2002) in which words are scored as correct if it is:

1) An exact match;

2) It includes incorrect tense or plural suffix but not in syllable, did not differ in any other syllable; or
3) The word was an ‘a’ or ‘the‘ substitution and did not differ in any other syllable.

Following Mattys & Liss (2008) in respect of dysarthric speech, equal weighing was given in the scoring of accurately transcribe words, that is all words were scored for accuracy without consideration of linguistic class.The results of the intelligibility tests are reported and discussed in Section 2 below.

SECTION 2: RESULTS OF INTELLIGIBILITY TESTS

6.12. Results

At completion of all tests, data was analysed and computed to show outcomes. The following section presents the results for all closed and open tests. comprising:

- Percentage intelligibility for all listeners for all tests.
- Intelligibility outcomes for naïve and familiar listeners.
- Influence of semantic and phonetic variables on intelligibility
- Association between utterance length and intelligibility.

See Appendix 1X for all raw data for intelligibility tests

Results for all tests were computed and checked subsequent to the tests, as shown

6.12.1. Intelligibility results

In the closed intelligibility tests listeners selected a target word from a closed list of

alternatives including the target word. Therefore there existed a predictable probability that listeners 'guessed' correctly by identifying targets by chance rather than perceiving each target word on the basis of retrieving sufficient acoustic information. In order to determine whether the results of the intelligibility tests differed significantly from listeners guessing the target word, the chi square Goodness of Fit Test was used. The distribution of the observed data (numbers of correctly and incorrectly identified words) was compared with the distribution of the predicted values in a contingency table. The alpha level was set to 05

A statistically significant result from chi squared indicated that there was a significant association between the data type (observed vs predicted) and accuracy. Where $p<.05$ for an individual test and the listener scores exceeded the predicted values it was concluded that there was a greater likelihood of accuracy when listening than guessing. The results of each test can be seen in Table 6.6. In all closed tests (1-7) greater accuracy was associated with listening than would be predicted if listeners were operating at chance levels ($p<.05$)

Table 6.6. - Chi-Squared Goodness of Fit results on closed tests 1-7

Closed Test no.	No. of test words	Degrees of free- dom	χ^2 value	p =
1	5	5	349.0	0.05
2	5	4	514.1	0.05
3	10	1	140.1	0.05
4	6	5	482.0	0.05
5	5	4	493.9	0.05

6	**5**	**4**	**376.9**	**0.05**
7	**6**	**5**	**447.0**	**0.05**

Table 6.6 shows that frequencies of accurate responses differed significantly from chance levels for Tests 1-7

Results demonstrate that we can reject the null hypothesis at $p<.05$

6.12.2. Results for closed tests 1-7

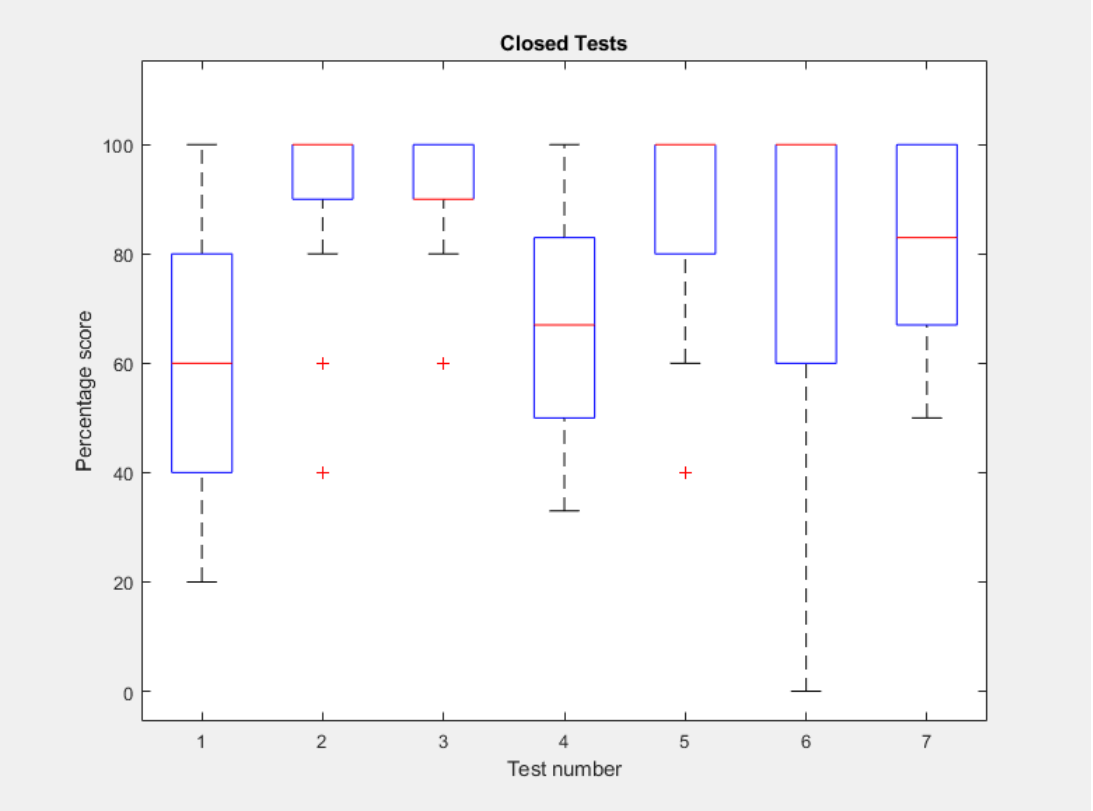
Table 6.7 below shows the mean percentage scores across all 40 participants for the closed tests 1-7. An indication of the spread of the results for each test is provided by the interquartile range.

Table 6.7 : The mean percentage scores across all 40 participants for the closed Tests 1-7.

Test no	Mean Test Score %	Interquartile Range (%)
1	61.0	40
2	91.5	10
3	90.3	10
4	66.7	33
5	89.5	20
6	80.5	40
7	85.0	33

The box plot in Figure 6.1 shows how the closed test responses varied across the cohort of listeners. Blue boxes denote the interquartile ranges, and red lines the median values. Any outliers are shown as red crosses.

Figure 6.1: Variations in listener closed test responses



6.12.3. Analysis of closed listener test results

As can be seen in Figure 6.1, closed Tests 1, 4 and 7 show even distributions, suggesting that these tests to have been reasonably challenging for the listeners. All remaining test results appear skewed towards the high end of the score range. Results showed wide variations between tests in individual listener scores (see the significant number of outliers and long “tails” in the plot in Figure 6.1). The overall scores (see Table 6.7) identified percentage intelligibility for all listeners to be between 61.0% and 91.5%. Mean scores for closed tests 2, 3, 5 and 7 were 85% and above, but those for Tests 1 and 4 were 61% and 67% respectively. This shows a strong tendency towards correct responses for most words heard by the participants, with a small number of

words or phrases less well understood. Some closed test questions were contextual so that the answers tended to be predictable. Additionally, variations in the quality of samples may have influenced perception, therefore explaining the high skewing towards full marks seen in tests 2, 3, 5 and 6. Moreover, the outliers seen in these tests indicate that there may have been some ambiguity in the questions.

The section below discusses the details of the closed listener tests of intelligibility. See Appendix 1X for Details of listener test results.

6.12.4. Results of Closed Test

Table 6.8: The results of Test 1 (Phonetic, syllabic and vowel differences)

Test 1 Correctly Scored			
Question	Word	Score	Percentage
a	Speak	35	87.5
b	Dad	24	60
c	Something	34	85
d	Perfect	15	37.5
e	Lucky	14	35
	Total	122	
	Max	200	61% Mean

The most noticeable outcomes for Test 1 are the difficulties for listeners in perceiving the words ‘Perfect’ and ‘Lucky’, both scoring much lower than others in the grid. For both these words, placed in the first test and therefore presenting listeners with little chance to adapt perceptually to SV phonation, lack of experience may have impacted on perception. However, three other target words precede ‘Perfect’ and ‘Lucky’ both achieving significantly higher scores. ‘Lucky’ is distinguished too by achieving the

lowest score for all closed tests, and by being aligned with the word ‘Late’ as a foil in a set where the first syllable is most prominent.

6.12.5. Results of Closed Test 2

Table 6.9 Results for Test 2 CVC words

Question	Word	Score	Percentage
a	Yes	40	100
b	Bus	38	95
c	Dad	35	87.5
d	Mum	36	90
e	Sit	34	85
	Total183	183	
	Max	200	91.5 Mean

Outcomes for all closed tests identified that CVC words (consonant vowel consonant) were most intelligible, achieving a percentage intelligibility score of 91.5%. The scores in Test 2 for CVC words were high, between 85% and 100% for all individual words. The results suggested that CVC words contained phonetic features conducive to intelligibility in SV utterances. A further examination of CVC words in the other tests showed that they scored between 60% and 100% percentage intelligibility, adding support to this assumption.

The CVC word ‘Dad’ appeared in 2 different tests, achieving a lower score in the earlier test than the later test. The low score in Test 1 might be attributed to the position of this item as the second word in the first test, proving problematic for listeners as they ‘attuned’ their listening to the atypical phonation that occurs in SV utterances. This

conjecture can be applied to Test 1 overall, scoring as it did the lowest score of all closed tests.

6.12.6. Results of Closed Test 3: Syllable Length

In Test 3, as shown in Table 6.10 below, where the influence of the number of syllables on intelligibility was specifically tested, all (4) bi-syllabic words achieved a percentage intelligibility score in excess of 90%. This contrasted with single syllable and tri-syllabic words where scores were lower. Bi-syllabic words might carry more perceptually available information than would single syllable words, thus achieving a higher score. However, on this assumption, tri-syllabic words should outperform other options, offering information across three syllables. That this is not the case may relate to the degree of respiratory energy available to participants producing the samples. Respiration may be sufficient for clarity on bi-syllabic options, providing more information than single syllable words, but reducing for longer words and thus reducing perceptually available information. Typically, participants found difficulty in maintaining respiratory energy, possibly with implications for production of number of syllables on occasions. However, over all tests, it was not possible to identify an association between intelligibility of SV utterances and syllable numbers. Moreover, there was an imbalance in the number of pairs in Test 3, with 4 bi-syllabic pairs, compared to three tri-syllabic pairs and 3 single syllable pairs. However, had an extra single syllable and tri-syllabic pair been added, potentially achieving scores of 40 (100%) each, scores would still have identified the bi-syllabic pairs as most intelligible. Nevertheless, a future test should be constructed with an equal number of pairs to ensure standardisation of test conditions.

Table 6.10: The results for Test 3: Syllable length

Test 3 Correctly Scored			
Question	Word	Score (Max score 40)	Percentage
a	Budgie	37	92.5
b	Medicine	39	97.5
c	Purple	40	100
d	Yes	40	100
e	Better	40	100
f	Said	33	82.5
g	Fabulous	32	80
h	Right	25	62.5
i	Summer	38	95
j	Brilliant	37	92.5
	Total	361	
	Max	400	90.3 Mean

6.12.7. Results of Closed Test 4: Distinct phonetic and phonemic differences

Test 4 explored the influence of distinct phonetic and phonemic differences in monosyllabic and bi-syllabic words. Table 6.11 below shows the outcomes. As can be seen, the word ‘Christmas,’ achieved a score of 100%, significantly better than the other words in this set, possibly reflecting listener familiarity with this word, in comparison with three other bi-syllabic words, ‘Father,’ ‘Super,’ and ‘Private,’ which were less well perceived. ‘Father’ and ‘Private’ were two of the least intelligible words across all closed tests.

See Table 6.11 below: Results of Test 4

Table 6.11. Results for Test 4

Test 4 Correctly Scored			
Question	Word	Score	Percentage

a	Home	24	60
b	Father	17	42.5
c	Christmas	40	100
d	Super	27	67.5
e	Care	31	77.5
f	Private	21	52.5
	Total	160	
	Max	240	66.7% Mean

6.12.8. Results of Closed Test 5: The influence of semantic context (colours)

Table 6.12. The results for Test 5 – the influence of semantic context (colours) on intelligibility

Test 5 Correctly Scored			
Question	Word	Score(Max score 40)	Percentage
a	Blue	39	97.5
b	Yellow	38	95
c	Red	39	97.5
d	Orange	28	70
e	Purple	35	87.5
	Total	**179**	
	Max	200	89.5 Mean

Two tests assessed listener intelligibility in relation to semantic class. As shown in Table.6.12.where the semantic context was ‘Colours,’ the influence of context on listener perception appears positive, with only the word ‘Orange’ scoring less than 80%. This test has the added advantage of a more limited available vocabulary, using commonly known words for colour so that listeners had a restricted lexicon from which to choose.

6.12.9. Results of Closed Test 6: the influence of semantic context (animals)

Table 6.13: The results for Test 6 – the influence of semantic context (animals) on intelligibility

Test 6 Correctly Scored			
Question	Word	Score (Max score 40)	Percentage
a	Fox	35	87.5
b	Sheep	35	87.5
c	Pig	25	62.5
d	Rat	30	75
e	Turkey	36	90
	Total	161	
	Max	200	80.0% Mean

Test 6 assessed listener intelligibility in relation to semantic class (animals.) As in Test 5 the influence of semantic class as a contextual clue for SV intelligibility appears to be positive. Results are lower in Test 6 in comparison with Test 5 and may reflect the more extensive lexicon available to listeners when 'animals' are the test items, particularly as the list of animals used is less commonplace than the list of colours. It is interesting to note that 'Pig' is the least well perceived item by listeners, perhaps reflecting the lack of movement by the primary articulators where the movement of the lips is a significant contributor to the sound of 'p'.

6.12.10. Results of Closed Test 7: the influence of experience on listener perception.

Table 6.14 below shows the influence of experience on listener perception (all words by the same speaker.)

Table 6.14: Results for Test 7 The influence of experience on listener perception (all

words by the same speaker**)**

Test 7 Correctly Scored			
Question	Word	Score	Percentage
a	Stop	40	100
b	Happy	40	100
c	Myself	40	100
d	Sorry	32	80
e	Dream	31	77.5
f	Listen	21	52.5
	Total	204	
	Max	240	85% Mean

Test 7 explored the influence of experience on listener perception, using the same speaker for all 6 target words. Results indicate very high scores for the first three words, declining for the following three, therefore suggesting that listeners failed to become perceptually familiar with the SV phonation of this participant, presenting as it does as atypical. However, it is also probable that the quality of the words presented declined being better and clearer samples for the first three words, and less so as the test progressed. The 100% achieved for the first three words supports the proposal that the quality of samples is a significant consideration for influence on listener perception. Good samples facilitate listener perception.

6.13. Most intelligible words

A number of words in the closed tests achieved 100% percentage intelligibility, as seen in Table 6.15 below

Table 6. 15 shows the most intelligible words across all closed tests, each scoring 100%

Table 6.15 : The most intelligible words across all closed tests 1-7

Test	Word	Score (Max score 40)	Percentage
Test 3	Better	40	100.0
Test 4	Christmas	40	100.0
Test 7	Happy	40	100.0
Test 7	Myself	40	100.0
Test 3	Purple	40	100.0
Test 7	Stop	40	100.0
Test 2	Yes	40	100.0
Test 3	Yes	40	100.0

The word ‘Yes ‘appeared twice in the highest scoring word list. Listener familiarity with the word Yes x 2 perhaps contributed to the ease with which ‘Yes’ was perceived, with the additional benefit of being a CVC word as CVC words were most intelligible over all tests. The word ‘Yes’ also occurred twice in open tests 8a and 9, as part of contiguous utterances, again achieving very high scores (‘Yes, everyday,’ Test 8a and ‘Yes, thank you’ Test 9) and was perceived by 100% of listeners in Test 8a and 98% in Test 9. The word ‘Yes,’ uttered either singly or as part of a contiguous utterance appeared to carry sufficient phonetic information to be easily perceived by listeners.

‘Happy’, ‘Myself’ and ‘Stop’ (Test 7) also achieved 100% intelligibility and were all samples by the same participant, testing listener ability to perceive words by the same SV speaker. The inclusion of 3 samples by Participant 2 in the highest scoring words perhaps benefitted from the ‘good’ quality of his SV phonation and, if this is the case,

a closer examination of his phonation may identify particular features conducive to intelligibility.

It is noticeable that 'Christmas' was among the 8 highest scored words across all closed tests. Listener perception may have benefitted from the use of Christmas as a proper noun of some significance to most listeners.

6.13.1 Least intelligible words

As seen in Table 6.16 below the least intelligible words were most apparent in Test 1 and Test 4, both of which contained 3 low scoring words out of 6 test items. As the first test undertaken by listeners, the novelty of exposure to items in Test 1 may have challenged listener perception but this did not apply to Test 4. Further examination of the influence on listeners of phonemic contrasts in both tests is needed.

Table 6.16 Least intelligible words across all closed tests.

Least intelligible words across all closed Tests 1-7			
Test	Word	Score (Max score 40)	Percentage
Test 1b	Dad	24	60.0
Test 4 S1	Home	24	60.0
Test 4 S6	Private	21	52.5
Test 7 S6	Listen	21	52.5
Test 4 S2	Father	17	42.5
Test 1d	Perfect	15	37.5
Test 1e	Lucky	14	35.0

There was no consistent variable for least intelligible utterances, positioned across tests and phonetic conditions. It is to be expected that the quality of the SV samples and the quality of the recording had some influence on intelligibility of low scoring

samples.

6.14. Results of open tests

Results for all open tests were computed.

Listeners correctly identified 1447 words from a word pool of 3080 in 3 open tests

Table 6.17 shows percentage intelligibility scores for 3 open tests – Test 8, Test 8a and Test 9.

Table 6.17: Percentage intelligibility scores for 3 open Tests – 8, 8a and 9

	Score	Max	Percentage
Test 8	219	320	60.6 Mean
Test 8a	322	840	38.3 Mean
Test 9*	906	1920	46.7 Mean

*Test 9 contains 23 different listeners to those participating in Tests 8 and Test 8a

Table 6.18 below shows the mean percentage scores for all 40 participants for the open tests 8, 8a and 9.

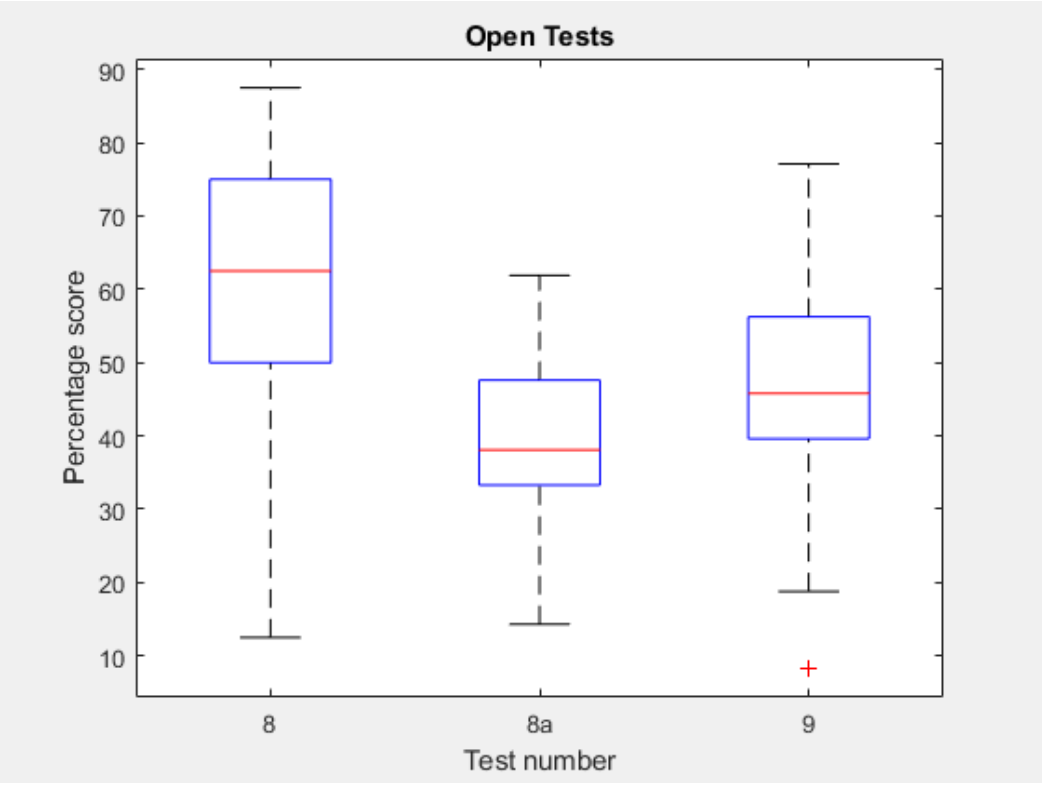
Table 6.18: The mean percentage scores and the interquartile range (%) for all 40 listeners for the open Test 8, Test 8a and Test 9.

Test no	**Mean Test Score %**	**Interquartile Range (%)**
8	60.6	25.0
8a	38.3	14.3
9	46.7	16.6

The box plot in Figure 6.2 below shows how the open test responses varied across the cohort of listener participants. Blue boxes denote the interquartile ranges, and red lines the median values (not the mean because median is not influenced by extreme values.)

Any outliers are shown as red crosses. Figure 6.2. below shows the variations between listeners across the 3 open tests.

Figure 6.2. Variations between listeners across the open tests, 8, 8a and 9.



The open tests in Figure 6.2. all have evenly spread distributions, although Tests 8a and 9 are very slightly skewed towards the lower end of the middle quartile. There is only one outlier point, in test 9. The overall mean scores (see Table 6.28) identified percentage intelligibility for all listeners to be between 38.3% and 60.6%.

The section below discusses the results of the open tests.

6.14.1. Results of Open Test 8

Table 6.19 below shows the results for open Test 8

Table 6.19 : Results of Open Test 8

Test 8 Correctly Scored			
Question	Word	Score	Percentage
a	England	35	87.5
b	David Cameron	42	52.5
c	Elizabeth	35	87.5
d	Paris	34	85
e	Washington	15	37.5
f	hundred	24	60
g	Thursday	34	85
	Total	219	
	Max	320	68.4

Test 8 achieved the highest intelligibility score (60.6) of the three open tests. In Test 8, target words were placed in carrier sentences using contextual cues but listeners were required to transcribe responses only if they perceived the answer. As required, listeners did appear to adhere to the requirement to transcribe what they perceived, rather than what they knew from the nature of the contextual cues, demonstrating their willingness to do so by ‘No Answer,’ responses where they would clearly know the answer. For example, twelve listeners failed to transcribe the answer to ‘How many pennies in a one pound coin?' demonstrating their perceptual failure to perceive the obvious and well known response.

6.14.2. Results of Open Test 8a

Test 8a included a range of contiguous utterances, requiring perception of connected rather than single words. Table 6.20 below shows the results for open Test 8a

Table 6.20 Results of open Test 8a

Test 8a Correctly Scored				
Question	Word	No of words	Score	Percentage
a	never	1	36	90.0
b	yes everyday	2	42	52.5
c	I am nervous	3	56	46.7
d	I am frightened	3	47	39.2
e	flowers for her birthday	4	20	12.5
f	I learnt that	3	53	44.2
g	she can not be here	5	68	34.0
	Total		322	
	Max		840	38.3

There was a significant drop in the overall percentage intelligibility for this test (38.3%) indicating the difficulties for listeners in perceiving contiguous utterances in open conditions, in marked contrast to those in closed tests with single words where the lowest test score (Test1) was 61%. A possible influence on the reduced outcomes may be that previous tests had included only one contiguous utterance (David Cameron, Test 8) so that Test 8a introduced listeners to a range of connected words for which they had little prior experience.

Data provided by Test 8a indicated an association between utterance length and intelligibility. As seen in Table 6.20 above, percentage intelligibility appears to reduce with utterance length in this test. A one word utterance ‘Never’ achieved a 90% score but utterances of 2 words length or more achieved less than 55%, dropping to 12.5 % for one 4 word utterance, although a 5 word utterance exceeded this score. This trend would suggest a negative association between increased length of utterance and

intelligibility in open conditions, a proposal that merits further examination in subsequent research

6.14.3 Results of Open Test 9

As seen in Table 6.21. below, overall percentage intelligibility for Test 9 was 47.2% for 40 listeners who correctly perceived 906 words out of 1920 target responses. Test 9 comprised 20 open questions with responses from 1 – 5 words in length, a significant increase in comparison with Test 8 and Test 8a each of which contained only 7 questions, only 1 of which was a 2 word utterance. Consequently, listeners were exposed to a more prolonged and difficult listener experience in Test 9 than they had been in previous tests. In addition, Test 9 included a number of contiguous utterances, presenting familiar listeners with a more difficult task than that included in Test 8 and Test 8a. Moreover, 23 new listeners took part in Test 9, all of whom were naïve listeners. New listeners made up more than half of the 40 listeners that participated and the novelty of the experience for them (in comparison with existing listeners) may have impacted outcomes. Nevertheless, results identified the ability of listeners to perceive meaning in SV utterances produced by children and young adults believed to be pre-linguistic and pre-verbal. Consequently, findings confirmed that utterances were intelligible and meaningful and perceived as such by both familiar listeners (who had the added advantage of their previous listener test experience) and 23 naïve listeners for whom the listening experience was totally novel.

Table 6.21: Results of open Test 9

Test 9 Correctly Scored					
Question	Answer	No of words	Words scored	Max Score (target words x 40 listeners)	Perc

1	the park	2	41	80	51.3
2	purple	1	39	40	97.5
3	letters	1	18	40	45.0
4	it is fine	3	50	120	41.7
5	swimming	1	18	40	45.0
6	crocodile	1	20	40	50.0
7	I talk to mum	4	58	160	36.3
8	right now	2	54	80	67.5
9	that is nice	3	65	120	54.2
10	that is me	3	48	120	40.0
11	college yes	2	42	80	52.5
12	she has forgotten	3	72	120	60.0
13	to dad	2	30	80	37.5
14	you are right	3	48	120	40.0
15	little bit different	3	36	120	30.0
16	I love my voice	4	44	160	27.5
17	they are good	3	49	120	40.8
18	say it again	3	45	120	37.5
19	red	1	23	40	57.5
20	yes thank you	3	106	120	88.3
Total		1920	906	1920	47.2

6.14.4. Length of utterance

Test 9 included a number of contiguous utterances of different length and word order. As with Test 8A, listeners perceived less as the utterance increased in length. Contiguous utterances of 3 words or more achieved less percentage intelligibility than did single or two word utterances in open conditions. The lowest scoring utterance (‘Flowers for her birthday’) in Test 8a was particularly problematic, with 16 listeners hearing ‘Flowers’ as the first word in the utterance and only 1 listener hearing ‘birthday’ at the end of the utterance. Similarly, the first word ‘She’ in the utterance ‘She cannot be here,’ was correctly transcribed by all 40 listeners but the last word ‘here’ perceived by only 9. Likewise, in Test 9 there appeared to be a trend towards reduced intelligibility with utterance length. Using data from Test 8a and Test 9, this was

examined by comparing utterances of different length with percentage intelligibility. As can be seen in Table 6.22 below, the trend towards reduced intelligibility with utterance length is maintained in both tests, although 3 x 4 word utterances achieved lower scores than did one 5 word utterance. The possibility of a negative association between increased length of utterance and intelligibility in open conditions merits further examination in subsequent research.

Table 6.22 Association between utterance length and intelligibility results

Number of words	Number of utterances	Words Scored	Max Total (words x number of utterances x 40 listeners)	Percentage
2	6	251	480	52.3
3	12	675	1440	46.9
4	3	122	480	25.4
5	1	68	200	34.0

Although there is a negative association between number of words and percentage accuracy, the influence of utterance length is indeterminate and further research is needed to identify if there is a causal link. In this study the data set contains more samples of shorter utterances of 3 or less words (18) in comparison with utterances of 4 words and above. The possibility that other factors have influenced outcomes, is yet to be explored. However, outcomes may relate to degradation in the acoustic/phonetic performance of participants (due to respiratory limitations) when using longer utterances, thereby reducing the degree of perceptual information available to the listener.

6.15. Familiar and naïve listeners

Closed tests 1-7

Results for familiar and naïve listeners in closed Test 1-7 were checked using 1 tailed t tests for Equality of Variances (equal variance not assumed) to check that data satisfied parametric assumptions of normality of distribution and homogeneity of variance.

The expectation that familiar listeners (i.e. those with 4 prior minutes exposure to SV utterances) would achieve higher percentage intelligibility than naïve listeners (no prior exposure to SV utterances) was not confirmed. Results identified that percentage intelligibility for both sets were similar as shown in Table 6.23. below.

Table 6.23. Number of correctly identified target words by listener type for closed Tests 1-7

Test	Familiar	Naive	*t(df)*	P =
1	65	57	0.32 (38)	.10
2	96	87	0.07 (38)	.04
3	93	88	0.22 (38)	.44
4	63	71	0.25 (38)	.095
5	89	90	0.44 (38)	.43
6	78	83	0.29 (38)	.29
7	85	85	0.5 (38)	.5

Table 6.23. shows that familiar and naïve listeners were able to retrieve very similar numbers of target words from the recordings in closed Tests 1-7. Only in Test 2 and Test 3 were the differences statistically significant (p values reported where equal variance is not assumed.)

6.15.1 Open Test 8 and Test 8a

Results for familiar and naïve listeners in open Test 8 and Test 8a were checked using 1 tailed t tests for Equality of Variances (equal variance not assumed) to check that data satisfied parametric assumptions of normality of distribution and homogeneity of variance.

Table 6.24. shows that familiar and naïve listeners were able to retrieve very similar numbers of target words from the recordings in open tests 8 and 8a.

Table 6.24. Number of correctly identified target words by listener type for open Test 8 and Test 8a

Test	Familiar	Naïve	*t(df)*	p (1 tail)
8	72	69	(38	0.23
8a	40	37	38	0.22
Mean Percentage	75	74		

N.B. Results for familiar and naïve listeners were not calculated for Test 9, due to changes in the original listener set so that the equal balance between naïve (20) and familiar (20) could not be maintained.

6.15.2. Combined results of closed and open tests

Intelligibility scores for closed and open tests were combined. Outcomes showed that 2,817 words were correctly identified in open and closed conditions out of a word pool of 4,760 .Table 6.25 below shows the combined outcomes for intelligibility results in both closed and open tests

Table 6.25. Combined intelligibility scores for open and closed tests

	Listeners	Scored	Max Score	Percentage
Test 1	40	122	200	61

Test 2	40	183	200	91.5
Test 3	40	361	400	90.3
Test 4	40	160	240	66.7
Test 5	40	179	200	89.5
Test 6	40	161	200	80.5
Test 7	40	204	240	85
Test 8	40	219	320	60.6
Test 8A	40	322	840	38.3
Test 9*	40	906	1920	47.2
Mean				71.80%
Total		2817	4760	59.20%

*Test 9 contains 23 different listeners to the original listener sets

6.16. Listener results

Block graphs were constructed showing listener results for correct and incorrect identification of target utterances on all closed tests. Error patterns specifically identified those utterances correctly or incorrectly selected by listeners, enabling later examination of the variations in listener perception. See Appendix XI : Block graphs showing error patterns on all listener tests. Scores for 40 listeners were collated per test and over all closed and open tests as shown in Table 6.26. belowTable 6.26: Listener scores in decreasing order for all tests 1-9.

Lis-tener num-ber	Famil-iar/Naïve	Test 1 / Score out of 5	T2/5	T3/10	T4/6	T5/5	T6/5	T7/6	T8/8	T8A/21	T9/48	Over-all/119	Percentage
1	F	3	5	10	6	3	5	5	5	11	33	86	72.3
27	F	3	5	10	4	5	5	6	6	10	32	86	72.3
5	N	4	5	9	4	5	5	5	6	6	34	83	69.7
2	N	4	5	9	4	5	5	6	3	10	31	82	68.9
3	N	4	4	10	4	5	4	4	5	4	37	81	68.1
15	N	4	5	8	6	5	5	6	6	11	21	77	64.7
8	N	2	5	9	4	5	5	6	6	11	24	77	64.7

38	N	2	4	6	3	3	5	6	3	11	34	77	64.7
4	F	3	5	10	3	5	5	4	6	13	22	76	63.9
12	F	4	5	9	2	5	4	6	5	9	27	76	63.9
32	N	1	3	10	4	4	2	5	5	9	32	75	63.0
19	F	4	5	9	4	5	5	6	7	7	23	75	63.0
37	F	1	5	9	5	5	5	5	4	9	25	73	61.3
25	N	3	5	8	5	5	5	6	4	7	25	73	61.3
33	F	4	5	9	4	3	3	6	1	6	32	73	61.3
16	F	2	5	10	4	5	5	5	5	10	21	72	60.5
24	F	4	5	9	4	5	5	6	7	7	19	71	59.7
30	F	4	5	8	2	5	5	4	5	7	24	69	58.0
13	F	4	5	9	3	5	4	5	4	7	22	68	57.1
10	N	2	5	8	4	3	1	6	3	8	28	68	57.1
26	N	3	5	9	3	4	4	4	5	9	22	68	57.1
29	F	2	3	10	5	3	2	6	4	7	26	68	57.1
17	N	2	3	9	4	5	3	5	5	8	23	67	56.3
36	F	2	5	8	6	4	0	6	5	12	19	67	56.3
18	N	3	5	9	4	5	5	4	4	7	21	67	56.3
20	F	5	5	10	2	5	4	4	6	7	19	67	56.3
35	F	4	5	8	4	4	1	6	7	8	19	66	55.5
7	N	4	4	9	5	2	5	6	5	3	23	66	55.5
31	N	3	5	9	4	5	5	5	6	8	15	65	54.6
34	F	3	5	10	4	5	3	4	4	12	15	65	54.6
14	N	3	5	9	6	5	5	3	6	10	30	65	54.6
21	N	1	5	9	5	5	1	5	4	8	22	65	54.6
22	F	3	5	9	2	3	5	5	4	4	23	63	52.9
9	N	3	3	9	5	5	5	5	5	3	18	61	51.3
23	N	4	5	8	5	5	5	4	5	9	9	59	49.6
11	N	3	2	9	2	4	3	6	4	6	19	58	48.7
28	N	2	4	10	4	5	5	5	4	7	11	57	47.9
39	F	3	5	9	6	4	5	5	6	10	4	57	47.9
40	F	4	5	9	3	5	3	4	3	5	12	53	44.5
6	F	3	3	10	2	5	4	4	6	6	10	53	44.5

6.16.1. The range for all listener scores was as follows:

- Highest: 86 words correctly perceived
- Lowest: 53 words correctly perceived
- The resultant range is 33.
- The percentage range is:
- Highest percentage intelligibility: 72.3%
- Lowest percentage intelligibility: 44.5%
- The resultant range is : 27.8%.
- The modal score across all tests is 65 (scored by 4 listeners)

40 listeners correctly identified;

- 1370 words from a word pool of 1680 in 7 closed tests 1422 words from a word pool of 3080 in 3 open tests
-
- A total of 2,775 words from a word pool of 4,760 in 10 tests in open and closed conditions out of a word pool of 4,760

6.17.Summary

Samples used in listener tests were amplified SV utterances produced by the research participants. The ability of 40 naïve and familiar listeners to perceive the utterances as intelligible supports the outcomes of Phase 1 where features integral to speech and whispers were identified and must have been sufficient in test samples for listeners to perceive and transcribe utterances. Results of listener intelligibility tests also confirms the presence of real words as single and contiguous phrases. Although it is not possible to ascertain why participants were unable to produce utterances as vocal

verbalisations, the intelligible outcomes resulting when utterances are artificially amplified suggests at least the partial operation of speech structures replicating those that facilitate normal verbalised speech.

Results from the closed and open tests of listener intelligibility identified the ability of listeners to perceive utterances in both closed and open conditions. Single words in closed conditions were most intelligible in comparison to single or contiguous words in open conditions. High scores were consistently evident for particular utterances in both the open tests and closed tests (irrespective of context or other cues) and further investigation is required to determine the attributes in the SV utterances or the listeners that contributed to these scores, in comparison to other responses.

Listener test samples included a range of words to identify the ability of listeners to perceive phonetic and syllabic features. Resultant data requires further investigation (currently beyond the remit of this research) to broaden the investigation into the association between listener results and the phonetic and syllabic features of the word samples. The outcomes of the listener tests of intelligibility potentially offer insight into a listener profile best suited to transcription/interpretation of SV utterances.

10 tests of intelligibility in closed and open conditions identified the ability of listeners to extract sufficient information from the samples to understand individuals normally considered to be pre-linguistic and pre-verbal. The expectation that listeners would consider the participants to be anarthric was confounded. The ability of naïve and familiar listeners to correctly perceive a range of SV utterances in both closed and open conditions confirms the hypothesis that SV utterances by children and young adults designated PMLD are intelligible to listeners.

CHAPTER 7 Phase 3

7.1. Introduction

Phase 3 addresses the research question:

How sophisticated is the language used in utterances? Does it demonstrate linguistic and cognitive levels beyond the developmental age of 0-24 months attributed to individuals designated PMLD?

This chapter presents Phase 3 of the research in which a quantitative methodology was used to assess the linguistic and developmental levels of SV utterances produced by the 20 research participants. The sample utterances were selected on the basis of the acoustic quality of the recordings. In order for participants to produce meaningful utterances, acquisition of levels (beyond pre-linguistic stages of infancy) at which language develops and operates must be present. Phase 3 was therefore designed to utilise appropriate assessments to compare the content of SV utterances with linguistic and developmental stages in normal language. Language is a recognised indicator of developmental and linguistic stages in normal language acquisition (Brown, 1973) so that the content and nature of utterances could show the stages and levels attained by participants. The acquisition by participants of developmental and linguistic stages in excess of those associated with infancy could be investigated and demonstrated if present. Within this remit, the presence and use of linguistic conventions could also be investigated, as indicative of the participants' acquisition of language rules demonstrating understanding of how language functions, particularly as communication. Finally, the content of utterances offered insight into the extent of

participants' knowledge and awareness of the world around them, providing additional data to show their developmental and linguistic levels aligned with normal language.

7.2. Rationale for assessing the linguistic and developmental content of SV utterances

An additional rationale for this approach relates to the acknowledged difficulties in any reliable assessment of individuals with severe impairments. The failure of participants to demonstrate responses to a range of test conditions, generally requiring visual or physical reactions, inhibited and distorted assessment outcomes. The absence of existing tests sensitive enough to show competence compelled reliance on unprecedented means of assessing participants to identify competencies otherwise obscured. This approach offered a means to better identify the real levels of individuals designated PMLD, in association with their ability to use meaningful utterances.

7.3. Measures for assessing the content of SV utterances

The first objective was to identify measures appropriate for assessing the content of SV utterances by participants. Commonly used assessments for normal children and children with learning disabilities up to 5 years were considered although this resulted in a mismatch between the age range targeted by assessments and the chronological age of a number of participants, only 2 of whom were under 5 years old. However, the common assumption that individuals designated PMLD are developmentally delayed gave reasonable cause to make use of assessments related to the early years (0 – 5).

Although assessments frequently incorporate both speech and language, concern was

with evidence of language only. For the purposes of this research, where verbal audible speech could not be produced by participants or articulation assessed, all items relating to speech development were discounted. Focus was on the language used. Consequently, reference was made only to assessment items that could be applied to the recorded language content of SV utterances.

In order to meet the above requirements, three forms of assessment were identified.

National Curriculum Performance Scales and Early Years Foundation Stages.(Gov.UK Department of Education and Standards and Testing Agency.)

Milestones Developmental stages in language acquisition (National Institute on Deafness and Other Communication Disorders (2000) Speech and Language Developmental Milestones. National Institute of Health (NIH) Publication No. 00-47)

Mean length of utterance (Brown, 1973)

The criteria and descriptors included in the above measures were itemised. Existing recordings were scrutinized for samples that met required criteria and/or descriptors. For the majority of participants, the study did not 'teach to the test' (DeFauw, 2013) but instead compared the content of existing SV utterances to standardised assessment items. In some instances however, where assessments included items absent from existing utterances, answers were elicited in the required form in order to ensure that clear evidence was obtained.

7.4. Performance Scales

The 1988 Education Reform Act introduced the National Curriculum to standardise the required attainment and assessment of pupils in state schools. The National Curriculum defined what children should be taught and what they should learn, setting priorities for pupils' education. Details of the knowledge, skills and understanding to be achieved at different levels in different subjects were set out. Although the National Curriculum was an entitlement for all children, policymakers failed to include those with special educational needs. However, in 1998 this oversight was remedied with the introduction of Performance Scales (P scales or P levels) for SEN pupils working below Level 1 of the National Curriculum, offering level descriptors to assess pupil learning. See Appendix XIX: Performance P Scale Attainment Targets for Pupils with Special Educational Needs (June 2017)

Currently, P levels are used for the assessment of children aged 5- 14 with special educational needs (SEN) who have not reached Level 1 of the National Curriculum. The scales provide a national standardised means of assessment, detailing specific objectives from P1 to P8, with P1 being the lowest level and P8 the highest on the scale. P levels offer performance descriptors within 8 levels for setting targets and tracking progress. Levels 1- 3ii are not subject specific and the same descriptors apply across all areas. Levels 4 – 8 are subject related, preceding the relevant subject descriptors in Level 1 of the National Curriculum.

Since the introduction of Performance Levels, government policy has changed and it is considered that they are no longer fit for purpose, following the Rochford Review in 2016 and the government response in 2017. They are to be discontinued and replaced by a new assessment system for PMLD pupils not engaged in subject specific teaching

and learning. It is anticipated that the new system will be introduced in 2020, replacing P levels with defined 'areas of engagement' currently being piloted, with emphasis on cognition and learning. In the interim, participants in this research study continued to be assessed and taught in relation to Performance Levels. Although the levels cover a range of areas (such as number and science) only those relevant to expressive language and communication were referenced for this research.

7.5. Structure of P Levels

Below P Level 4, Scales 1-3 are not subject specific and attainment at levels 1 – 4 generally designate pupils as PMLD, reflecting criteria representative of developmental stages in infancy. Consequently, below P4, descriptors specific to language are absent as this is not expected to be present in such early stages. Instead, an overall descriptor is used that applies to all subject areas. At P4 -8 separate performance descriptors can be given in reading, writing, speaking or listening as the emergence of language is anticipated. In this research, reference was made to descriptors and targets for P1 – 4 and to descriptors P4-8 for Speaking (where developing language is encompassed). 'Listening' is also included in the scales but was not used as this research is concerned with expressive language. Moreover, the descriptors for 'Listening' largely require physical or behavioural responses beyond the physical abilities of any of the participants.

7.6. Early Years Foundation Stages

As with Performance Scales, EYFS provides a statutory framework of learning for providers meeting the needs of pre-school children (0-5.) See Appendix XX for Early Years Foundation Stages (EYFS.) For two 3 year old participants, EYFS was a

statutory requirement and therefore used for teachers in the schools where the research was conducted. Introduced in 2017, it details requirements for learning and development of pre-school children (0-5) specifying 3 prime areas.

- communication and language
- physical development
- personal, social and emotional development

EYES includes assessment requirements, including those related to communication and language, used to assess children's ability to speak, pay attention, listen and understand. Unlike P levels, descriptors are age related, indicating when behaviours are expected to occur in relation to normal developmental stages. For the purposes of the research, as with P levels, only items related to or indicative of language stages were assessed on EYFS.

P levels and EYFS set specific objectives with accompanying descriptors, against which individuals could be assessed. Although both assessments examine a range of behaviours and abilities – mobility for example - they were used only in respect of language and communication. Due to the sensory and motor impairments that characterised the participants in this research, assessment on P levels placed them at stages P1 –P4 and for two participants assessed on EYFS at 1b and 1c. Thus, assessment outcomes placed participants developmentally within infancy, meeting the targets and descriptors included within these levels. Abilities, if they existed, could not

be demonstrated or ascribed by observation of their limited behaviours. Thus, below P4 and at early stages in EYFS, assessment placed participants at pre-linguistic and pre-verbal levels by their failure to meet targets that necessitated an active physical, visual or verbal response. Competence if it existed, was obscured.

7.7. Language assessment levels on Performance Scales and EYFS

Due to the difficulties described above, individuals inevitably achieved assessed levels aligned with attainments that entailed very limited responses. Such responses, often deteriorating with growth or age, placed them at very early stages, often maintained over years as their failure to demonstrate competence persisted. The limitations arising from their sensory and physical impairments meant that they could not be seen to progress to higher levels, thereby confirming the assumption of their profound cognitive, developmental and linguistic impairment even as they grew older.

Prior to joining the research programme, all participants were assessed on P Scales or EYFS by their teachers. The assessments identified them as having very limited language competence or as pre-linguistic. Table 7.1 below identifies the levels ascribed to individuals.

Table 7.1 Results of Teacher Assessment of Participants on Performance Scales and EYFS.

Participant	Participant age at assessment	P Level	EYFS	Date assessed
1	20	3iia		Sep-15
2	11	4b		Jun-15
3	17	4b		Jan-15
4	6	4b		Jun-17
5	6	3iia		Jun-17
6	3		1b	Dec-17

7	10	4a		Jan-17
8	13	4b		May-15
9	13	4b		Dec-17
10	11	4b		Jan-17
11	10	3i b		Dec-17
12	12	4a		Jan-17
13	13	4b		May-16
14	15	4b		May-15
15	3		1a	Dec-18
16	17	4c		Jan-15
17	10	3i		15
18	8	2iia		May-15
19	5	1iia		Jun-17
20	11	4a		Oct-18

7.8. Performance descriptors on P Scales and EYFS

Despite the difficulties in assessing participants due to their failure to respond appropriately as described above, the items included in the P levels and EYFS assessments offered a coherent structure against which to compare SV utterances. Both measures are consistent across all special schools and follow a developmental sequence. They offer a framework within which participant abilities had been evaluated by their teachers, prior to entry to the research programme and therefore without reference to their SV utterances. Comparing the attributes ascribed to individuals on P scales and EYFS with the attributes demonstrated by SV utterances offered the means to identify levels derived from language performance, rather than observed behaviours restricted by impairments. Samples of SV utterances were therefore collated and compared to P Levels and EYFS levels.

7.9. Samples of SV utterances for assessment

For language samples Muller (2013) reports that the speakers self-generated

language, spontaneously delivered, has the highest face validity. For this study, spontaneous data was acquired during recordings when participants led the conversation or were given time to 'Say whatever you want to.'

7.10 . The content of SV utterances aligned with P Scales and EYFS

In order to compare SV utterances against items in the P scales and EYFS, a standardised procedure was employed as follows:

Teachers established levels on P Scales and EYFS, without reference to the researcher and prior to the invitation to the participant to join the research cohort. Assessments were P4 and below for 18 participants on P scales and 1b and 1a for 2 participants assessed on EYFS.

This provided the baseline for individuals against which SV utterances could be compared and evaluated. Using the content of utterances, participants were assessed again against descriptors and targets itemised in the assessments, seeking a level at which the content of utterances met the required target and descriptors.

The process of comparing the content of SV utterances against the assessment items could be continued in order to reach the highest level reflecting abilities made evident in utterances, yet using the structure of the appropriate assessment as indicative of what should be considered and compared. Where levels were indicated, recordings were scrutinized to provide adequate evidence of competence over a range of utterances, not simply from isolated sections.

An example below demonstrates the process, using samples selected from a range

provided by the participant.

Participant 18 is severely physically impaired. She cannot move her torso, limbs or head independently. She has significant problems with respiration (causing gaps in her utterances) and a range of complex medical problems. She was assessed at P2 when entering the research programme in 2015 as an 8 year old and had been assessed at the same P level during the previous 3 years (2012, 2013, 2014.), She had therefore attained the P level targets below, denoted by italics:

P2 (ii) Pupils begin to be proactive in their interactions
They communicate consistent preferences and affective responses [for ex- ample, reaching out to a favourite person]
They recognise familiar people, events and objects [for example, vocalising or gesturing in a particular way in response to a favourite visitor] They per- form actions, often by trial and improvement, and they remember learned responses over short periods of time (for example, showing pleasure each time a particular puppet character appears in a poem dramatized with sensory cues)
They co-operate with shared exploration and supported participation (for ex- ample taking turns in interactions with a familiar person, imitating actions and facial expressions)

P2 identifies communication behaviours typically within the repertoire of infants, where pre-linguistic, early communication is described. Assessment of her P Level at P.2.iia places her firmly within the pre-linguistic developmental stage. There is no evidence to indicate any language acquisition. Participant 18 could not reach out to a favourite

person or perform actions often by trial and improvement as she had no control over her very restricted movements but she could show pleasure in the presence of a known adult, smiling and vocalising.

In contrast to the assessed levels identified on P scales at P2iia, SV utterances recorded by Participant 18 provided evidence of linguistic abilities in advance of the itemised descriptors.

During her first recording, the teacher is giving her a hand massage. She tells the teacher sub vocally:

Chapter 7 a sample

I like it

I like.. this

The researcher recorded then later played back the SV utterances to Participant 18. Participant 18 responds :

Chapter 7 b sample

This time, we have done it.

I whispered the sound

Super stuff

Participant 18 uses SV language to communicate her likes and preferences – ‘I like it,. I like this’ - which is significantly more developmentally advanced that the ‘vocalising or gesturing in a particular way’ identified in the P Level descriptor at 2iia. Matched against the targets in P Scales, she exceeds them, demonstrating greater competence in the identified areas and her use of language. She is not pre-linguistic.

Further recordings were undertaken, and utterances compared against higher levels, seeking to relate the content to more competent performance.

Utterances from Participant 18 were next compared to P4 attainment targets and performance descriptors, denoted by italics below:

P4 Pupils repeat, copy and imitate between 10 and 50 single words, signs or phrases or use a repertoire of objects of reference or symbols

They use single words, signs and symbols for familiar objects [for example, cup, biscuit], and to communicate about events and feelings [for example, likes and dislikes].

Chapter 7 sample c

Researcher: Can you tell me your favourite animal?

Participant 18: I like…. birds.

R: Would you prefer us to record you in the classroom?

Yes, that, thanks.

It's so busy in there.

Participant 18 meets targets for P4

She does not 'repeat, copy and imitate between 10 and 50 single words,' but simply uses her own contiguous vocabulary to say what she likes and converse with the researcher. She uses sentences, including the plural form (birds) instead of single words. She uses sentences to express her preferences.

Further utterances by Participant 18 are next aligned with P8 on P scales.

She likes the computer to record and play back her utterances. She tells the researcher about it, and meets targets for P8

P8 They link up to four key words, signs or symbols in communicating about their own experiences or in telling familiar stories, both in groups and one-to- one

They use an extensive vocabulary to convey meaning to the listener

They can use possessives [for example, 'Johnny's coat']

The researcher asks if she should put the bag (with the recording equipment) on the handle of the wheelchair. Participant 18 responds.

Chapter 7 sample d

I'd keep that there

Could I learn to rely on that?

I might talk back

With the computer, I could try

I've come here Rosie to record

Using the content of SV utterances, the linguistic and developmental abilities of Participant 18 could be compared with the criteria for P scales. As she could demonstrate her language to meet criteria at increasingly advanced levels, it was apparent that she is not profoundly intellectually disabled, and not functioning as an infant. She is not pre-linguistic. She is operating at levels above those that designate individuals PMLD and could demonstrate her competence within the P scales framework that guides and informs the assessment.

7.11. Results of p levels and EYFS assessments

The process of comparing P levels attributed by their teachers with P levels/EYFS identified by the content of SV utterances was undertaken for all 20 participants. This process provided evidence of higher levels than had been possible to identify without recourse to utterances. For the 2 participants (Participant 6 and Participant 15) originally assessed on EYFS, results identified acquisition of Performance Level items. Consequently, their assessment results were included as P level outcomes. The table below identifies the differences between the original assessment outcomes identified by teachers (prior to recording of SV utterances) and the assessments outcomes identified subsequently using the content of SV utterances.

Table 7.2 shows:

- assessment outcomes without the use of SV utterances
- assessment outcomes using SV utterances

Table 7.2 Assessment outcomes with and without the use of SV utterances

	Assessment outcome without SV utterances		Assessment outcomes using SV utterances	
Participant	P Level	EYFS	P Level	EYFS
1	3iia		P8	
2	4b		P8	
3	4b		P8	
4	4b		P7	
5	3iia		P6	
6		1c	P6/7	
7	4a		P8	
8	4b		P8	
9	4b		P6/7	
10	4b		P8	
11	3ic		P8	
12	4a		P7	
13	4b		P8	
14	4b		P8	

15		1a	P7	
16	4a		P8	
17	3i		P8	
18	2iia		P8	
19	1iia		P6/7	
20	P4		P8	

NB Two 3 year old participants (P6 and P15) were originally assessed with EYFS but meet targets on P Level descriptors as represented on Table 7.2

Using SV utterances, all participants demonstrate competence beyond the levels original identified by teacher assessments.

13 participants met descriptors for P8 as a minimum 3 participants met descriptors for P7

participants met descriptors at both P6 and P7 1 participant met descriptors at P6

Where 2 levels are indicated for individual participants (e.g. P6 and P7) the researcher and the three moderators found evidence at both levels.

Where 13 participants achieved P8, assessments indicated the probability of competencies beyond this level. Further assessment is needed to establish the highest abilities of the individuals concerned.

As can be seen from the P Levels/EYFS Table 7.2 above, there is a difference ascribed to pupils with and without reference to SV utterances. Using SV utterances, pupils achieve significantly higher against the standardised measures used for assessment in special schools. Original P level/EYFS scores without recourse to utterances inevitably reflected the physical and sensory impairments of the participants. Limited performances resulted that were below the ability levels apparent when SV utterances could contribute to the assessments. A marked discrepancy was

identified.

7.12. The strengths and limitations of assessments using P Scales and EYFS

In seeking a means to evaluate linguistic and cognitive competence represented by the content of SV utterances, P scales/EYFS had the advantage of offering standardised and credible assessments used nationally. However, as with many other assessments, they also incorporated a range of items requiring action or movement that could not be demonstrated by individuals with severe motor or sensory impairments, therefore limiting the means for individuals to demonstrate competencies. For participants in this research, all of whom were assessed by teachers on P scales or EYFS, the possibility that inaudible language might exist would not be made evident by their responses. Nevertheless, the targets and descriptors used in the P scales and EYFS offered specified criteria against which to consider the utterances, both in terms of grammar and vocabulary and the focus of their communicative efforts. If SV language could be accessed, the structure and content of Performance Scales provided descriptors against which the content of SV utterances could be precisely compared, identifying discrepancies between previously assessed levels and levels subsequently identified by the language content of utterances.

All participants were assessed on P levels, including two originally assessed on EYFS. This was because their recorded SV language met P level targets, enabling comparable assessment for the whole research cohort. However, unlike EYFS, P levels are not age specific, which is both an advantage and a disadvantage for use with participants. Although the scales relate to stages within infancy, precise

comparisons with age in months are not made. Consequently, P level outcomes for participants could not be related to chronological age. However, it is self-evident that achievements at P4 (Pupils repeat, copy and imitate between 10 and 50 single words) indicates developmental delay in a 20 year old individual, if there are no reasons to question that outcome. Conversely, if the content of SV utterances suggest as yet unidentified competencies beyond the P level descriptors, further assessments are necessary to discern if this is indeed representative of him or if higher levels could be identified by a more extensive assessment using the language in his utterances.

7.13. Speech and language developmental milestones

As already noted above, P levels and EYFS include a range of targets and descriptors that cannot be demonstrated by individuals with severe sensory and physical impairments. Moreover, P levels are not intended for use with normal children, having been developed for special educational settings, and comparison with their development is not catalogued for this measure. Consequently, in order to utilise assessments commonly used with normal children (0-5 years) that offer comparison with normal language development, an additional assessment was utilized.

Language development for normal children follows recognised developmental stages that can be identified and related to chronological ages. Speech and Language Developmental Milestones provide just such a measure. See Appendix X11: Speech and Language Developmental Milestones. Although acquisition of language reflects a variety of influences and experiences upon the child, the acquisition of anticipated language is commonly described as milestones; the developmental stages at which use of identified forms of language should be present. Thus, milestones can be

correlated with stages of language acquisition for both normal children in their early years, and those with developmental delay. In addition, the use of this measure for participants reflects the common assumption that individuals designated PMLD are developmentally delayed such that it is reasonable to make use of assessments related to the early years.

The understanding that language is a developing process, whereby linguistic forms are built up accumulatively is, according to Oller et al (2014) one of the principles that scholars agree on (Oller et al, 2014., Schulz, Wyeth and Wiles 2011., Walker-Andrews and Bahrick 2001,) Phonetic features precede syllables, syllables precede words, words precede sentences. The understanding and use of complex phrases cannot operate without first acquiring the meaning of some or all of the words included. It is anticipated that language becomes more complicated as the individual matures, with increasing complexity and richness of the lexicon and knowledge systems that underpin language. Consequently, some developments must occur before others and the identified milestones occur in a predetermined sequence. There may be variations in the rate of progress but the sequence does not change.

Developmental milestones in normal speech and language are catalogued (National Institutes of Health 2009.) Williamson (2014) reports that typical utterances of two words occur at 20-30 months, four words long at 28-42 months and up to six words long at 34-48 months. Utterances exceeding 6 words occur from 48 months. The National Institute of Health (2009) attributes sentences of 8 or more words in length to 5+. This research therefore explored the potential use of Speech and Language Developmental Milestones as a measure suited to the assessment of linguistic and

cognitive abilities demonstrated by the content of SV utterances.

7.14. Comparing SV utterances with Developmental Milestones

As noted above, there is a sequential order to the development of expressive language used by children. Increase in the number of words used reflects growing competence so that a one word utterance is developmentally less advanced than a three or four word utterance. Milestones identify the progression. Comparison of participant utterances with milestones in normal children enabled SV utterances to be measured for participants who lacked all other means of demonstrating competence.

7.15. Method of comparing SV utterances with Developmental Milestones

The National Institute of Health (2009) Speech and Language Developmental Milestones were used. Criteria for milestones for speech were not referenced as participants lack verbal speech. SV utterances were recorded and the best quality samples selected, authenticated by participants. The content and number of words in the utterances were itemised.

The content and number of words in SV utterances were compared with the assessment criteria identifying developmental milestones for normal language acquisition. Where the content and length of SV utterances matched that detailed by the descriptors for identified milestones, that milestone was ascribed to that participant. By using a range of utterances, samples could be credited as standard for the individual. The samples below demonstrate the process as participants provide evidence of the acquisition of milestones from 3-4 years up to 5 years as a minimum.

7.16. Milestones at 3-4 years

4 participants (6 years and under) achieved milestones at 3-4 years meeting the criteria, denoted in italics below:

1. *Groups objects such as foods, clothes etc.*
2. *Identifies colours*
3. *Able to describe the use of objects such as "fork," "car," etc.*
4. *Expresses ideas and feelings rather than just talking about the world around him or her.*
5. *Uses verbs that end in "ing," such as "walking," "talking."*
6. *Answers simple questions such as "What do you do when you are hungry?"*
7. *Understands spatial concepts such as "behind," "next to."*
8. *Understands complex questions*

Some samples are presented below

:*Identifies colours*

Describes how to do things such as painting a picture

Chapter 7 sample 7 e

Researcher: Can you tell me what colour your jumper is?

Participant 15: Got to say blue

Researcher: Tell me how you paint a picture

Participant 15 We cover it in paint. We wash the pot

Answers simple questions

Uses verbs that end in 'ing' such as 'walking,' 'talking'

Chapter 7 sample 7 f

Researcher: Can you tell me what you do when you're hungry?

Participant 6: I felt it today….biscuit

Researcher : Do you know why birds build a nest?

Participant 6: Their chick

Researcher: What do we put on to keep us warm when we go outside?

Participant 6: My ..raincoat…hear rain

Participant 6: Listen, I'm speaking

Expresses ideas and feelings

Chapter 7g sample

Participant 5: It makes me anxious

Researcher: I can hear your voice (via the laptop)

Participant 15: It's something that I can. Wonderful

Participant 19: That's nice.

Describes the use of objects

Participant 6 wears headphones that playback his own SV voice into his ears. He describes it

Chapter 7 h sample

.

Researcher: When you're wearing the headphones, what does it do for your voice?

Participant 12: I get the voice

It helps, I shout

Understands complex questions

A complex question is one in which there is an assumption that something is already answered. In the complex question below, the assumption is that the participant has 'talked' as the researcher asks about the quality of the talking.

Chapter 7i sample

Researcher: We're listening for words today aren't we?

Participant 5: That's a problem

It is me who speaks

Researcher: Did you do some good talking for us (complex question)

Participant 5: Yes, Mother…

Words

You must reward me

7.17. Milestones at 4-5years

3 participants achieved milestones at 4 – 5 years. Meeting the following criteria.

Says about 200-300 different words

Uses some irregular past tense verbs.

Defines words

Some samples are presented below:

Uses some irregular past tense verbs

Chapter 7 j sample .

Participant 9: I've just spoken….again

Spoke of … Rosie

My mum seen me do it

Researcher: The bell on the bus went ding dong ding

Participant 4: I pressed one

That's what I said

Defines words

Chapter 7 k sample

Participant 12: Let me have it

Researcher: If you pull them, they'll break

Participant 12: It's fragile

Researcher: Lion

Participant 4 : Lion. The beast. They are strong. Did it roar?

Researcher: What about apple?

Participant 4: Apple. In the dining room

Describes how to do things

Participant 12 describes how to use the headphones for our recording

Chapter 7 L sample

Researcher: Use your headphones. Who can you hear?

That's me!

Put that near me again

Let me have it

You talk with this

7.18. Milestones at 5 years

13 participants achieved milestones at a minimum of 5 years, meeting the following criteria.

Engages in conversation

Participant 8 has a conversation with the researcher. The researcher, who cannot hear his responses, relies on Participant 8 to use appropriate turn taking, one of the essential elements of conversational exchange. Participant 8 also demonstrates joint focus of interest by focussing on the first point introduced by the researcher and switching his focus to the second issue that she introduces.

Chapter 7 m sample

Researcher: There's a man coming next week who will visit us.

Participant 8: What's his name?

She's forgotten.

Researcher: Would you like to say something for mum because we could have a message on the computer for mum?

Participant 8: She's not home.

Love me. We should say that

Sentences can be 8 words or more in length.

Uses compound and complex sentences

Chapter 7 n sample

Participant 20: This one's good (wheelchair) man came to mend it

Participant 11: Yes…It's Rosie Woods, sitting next to me.

Participant 10: I'm lucky ..she hears.

Participant 7: You voice it and I think it's beautiful

7.19. Results of assessments of developmental milestones

Using the content of SV utterances, all 20 participants demonstrated expressive language beyond that of 0-24 months in relation to developmental milestones.

13 participants achieved milestones at a minimum of 5 years

3 participants achieved milestones at 4 -5 years

4 participants achieved milestones at 3 – 4 year

Table 7.3: Participant acquisition of developmental milestones.

Partici-pant Number	MILESTONES National Institutes of Health 2009		
	Milestones for 5 years	Milestones for 4-5 years	Milestones for 3-4 years
1	x		
2	x		
3	x		
4		x	
5			x
6			x
7	x		
8	x		
9		x	
10	x		
11	x		
12		x	
13	x		
14	x		
15			x
16	x		
17	x		
18	x		
19			x
20	x		

It is noticeable that the four participants achieving milestones at 3- 4 years are the

youngest in the cohort. P6 and P15 were both 3 years at the time of recording, P 6 and P19 (5 and 6 years old)

The 13 participants achieving milestones at 5 years may have the potential to exceed the developmental stages identified. Further assessment is required to establish their optimum levels.

The criteria for acquisition of milestones at the developmental level of 5 years includes, ‘Uses imagination to create stories.’ As participants were not asked to ‘use imagination,’ during recording sessions, this was absent from recorded tracks. However, although evidence of imaginary concepts were not sought in this study, the presence or absence of such concepts remain an area for future research.

7.20. Strengths and limitations of speech and language developmental milestones

The developmental milestones used in this research were applicable to children from 24 months up to 5 years old, thus encompassing stages and descriptors for language acquisition beyond infancy and up to 5 years. A particular strength of Speech and Language Developmental Milestones is the recognised association with language (and cognitive) development of normal children. Comparison of SV utterances with milestones could indicate the extent to which participants were progressing through normal stages of language acquisition as well as showing the levels attained.

The comparison between milestones achieved and chronological ages of participants also allowed consideration of the extent to which participants were developmentally

delayed. Achievement of milestones between 3- 4 years for a six year participant may indicate delay in comparison with normal peers but is not excessive if related to the degree and extent of his/her impairments (and lack of normal educational experiences.) However, for a participant of 20 years + attainment at 5 years suggests more marked delay unless further more age appropriate assessments move him beyond the outcomes on Developmental Milestones. Where participants exceeded descriptors for milestones at 5 years old, (the highest on the ASHA scale) showing that milestones have been achieved at this level as a minimum, reference to a different and more advanced means of language assessment is required. For 13 participants who demonstrate milestones at a minimum of 5 years, the scale for developmental milestones as an assessment of linguistic competence was limited.

As with P Scales and EYFS, developmental milestones include a range of descriptors that participants could not demonstrate due to their physical and sensory impairments. Thus, comparison with milestones for normal children have some limitations for those with severe physical and sensory disabilities that obscure demonstration of some descriptors. Results are therefore constrained.

7.21. Mean Length of Utterance

Mean Length of Utterance provides a recognised, standardised measure of expressive language. Seminal work by Brown (1973) details a normative account of stages in language development in pre-school children related to length and complexity as identified by the number of morphemes. As with milestones, the use of this measure for participants reflected the common assumption that individuals designated PMLD are developmentally delayed such that it is reasonable to make use of assessments

related to the early years.

An utterance can be an incomplete spoken group of words produced as a natural unit of speech, but may not be a sentence. An utterance ‘Me want,’ for example is an utterance but not a sentence. A sentence conveys a complete meaning. For the purposes of this research, only utterances that are sentences were scrutinized for MLU. MLU refers not only to the length of an utterance but the morphemes included within it. Morphemes refer to the meaningful elements in the utterance, capable of creating a difference in meaning, which includes both the words and the additional units that increase the complexity of the words. ‘S’ for example, introduces the plural across a wide range of words, so that the one morpheme in ‘cat’ becomes more complex with the additional morpheme to produce the plural ‘cat/s’ – now including 2 morphemes. Thus, MLU encompasses both word number and complexity of utterances. MLU is therefore defined as the average length of the utterance in morphemes. Rice et al (2010) examined aged referenced MLU for both normal and language impaired children, and concluded that MLU is a reliable and valid measure of language acquisition in both cases, encompassing measures related to both sentence length and grammatical competence. Casby (2011) too acknowledges MLU as a valid and frequently used measure of the expressive language of young children

This study references the protocol by Johnson (2005) where the method of counting morphemes is clearly defined.

See Figure 7.1. below:How to count morphemes

How to count morphemes

Method:

1 Select 100 completely intelligible utterances (i.e. if even one word in an utterance is not understood, that utterance is excluded from the analysis. Words that are unintelligible are transcribed as x.)

2 Count the morphemes in each utterance according to the guidelines set out in the 'DO count' and 'DO NOT count' sections below.

3 Add the number of morphemes for all 100 utterances to give a total number of morphemes used.

4 Divide the total number of morphemes used obtained in step 3 above by 100 to get the mean length of utterance.

DO count:

1 The -s plural marker (e.g. *cat-s, dog-s*). Count it even when used on irregular plurals (e.g. *mouse-s*). [Exception: plurals never occurring in the singular (e.g. *pants, clothes*) count as just one morpheme.]

2 The -ed past tense marker (*walk-ed, play-ed*). The -ed morpheme is counted even when used improperly (*go-ed, drink-ed*).

3 The -ing present participle marker (e.g. *walk-ing, count-ing*).

4 The -s 3rd person regular tense marker (e.g. *he like-s sweets, Bob walk-s fast*). [Exception: *does* counts as one morpheme.]

5 Possessive -'s marker (e.g. *mummy's hat, boy's toy*).

6 Contractions (e.g. *she's, he'll, they're, what's, she'd, we've, can't, aren't* would all count as 2 morphemes each). [Exceptions: *let's, don't* and *won't* are assumed to be understood as single units, rather than as a contraction of two words, so are just counted as one morpheme.]

DO NOT count:

1 False starts, reformulations, or repetitions unless the repetition is for emphasis (e.g. "[then] then [he go] he went to the zoo" is counted as 6 morphemes; "No! No! No!" is counted as 3).

2 Compound words, reduplications, and proper names count as single words (e.g. *fireman, choo choo, Big Bird*).

3 Irregular past tense verbs and irregular plurals count as one morpheme (e.g. *took, went, mice, men*).

4 Diminutives (e.g. *doggie, horsie, dolly*) and catenatives (e.g. *gonna,*

wanna, hafta) count as one morpheme.

5 Fillers (e.g. *um, well, oh, um hmm*).

Although there is considerable variation in the number of morphemes in an utterance at any point in the child's development, there is a sequential order to language development that relates the utterance to age. Thus, samples analysed in this way can provide an Age Equivalent, reflecting growing length and complexity of word use with increasing age. Age Equivalent is representative of the age at which the majority of children would produce an equivalent utterance, according to Miller (1981) but, although Garton and Pratt (1998) agree that there is a positive correlation between an MLU and chronological age, they consider the correlation to be weak. Nevertheless, Miller (1981) tabulates MLU to Age Equivalent in normal children, providing a commonly used standard against which to map SV utterances and providing a framework for meaningful comparison. See Figure 7.2 below

Figure 7.2 : Mean Length of Utterance (MLU) by Age [Source: Miller ,1981)

MLU	age equivalent (within 1 month)
1.31	18
1.62	21
1.92	24
2.54	30
2.85	33
3.16	36
5.63	60

3.78	42
4.09	45
4.40	48
4.71	51
5.02	54
5.32	57
5.63	60

7.22. The nature of samples used for MLU

The protocol for MLU requires utterances in which, all words are intelligible so that utterances with even one unintelligible word are excluded. Due to the atypical nature of SV utterances and problems with quality of samples some words were less clear than others. However, these were still counted where the intended word was obvious as reference to MLU in this research was concerned with the content, rather than the articulation of utterances.

In some cases, utterances were affected by the respiratory limitations of participants (as described above) and many produced intermittent phonation as respiratory energy was exhausted. Words normally joined were often separated by pauses, as the participant waited for additional breath. Gaps in phonation occurred, until sufficient breath became available to complete the comment, although the intention to complete the utterance was clear by the contiguous nature of the words. Transcription therefore, treated utterances as continuous, where it was apparent that this was intended.

7.23. Number of utterances

Conventionally, clinical practice uses a minimum of 50 to 100 samples of contiguous, intelligible utterances to calculate MLU. However, Casby (2011) investigated the effectiveness of calculating MLU, using from 10 – 150 utterances and found that much smaller samples maintained consistency of MLU and measures of statistical differences across the utterances. Results demonstrate the reliability and efficiency of MLU on smaller sample sets illustrating that the number of morphemes in a limited number of utterances can be indicative of expressive abilities. A contrary view from previous studies stresses the relationship between accuracy of results and the number of sample utterances, with increased samples resulting in increased accuracy. (Bishop and Adams, 1990, Miller and Chapman, 1981;). An increase in the number of utterances increases the available morphemes to augment the required evidence. In this study, there were limitations in examining numbers of utterances due to the limited resources of the researcher and the quality of the samples. The collection of sample sets of 50-100 utterances for all participants was not viable, and smaller sample sets were examined as a means to test the protocol rather than provide a definitive measure for each individual. Generally therefore, a minimum of 10 utterances per individual were scrutinized. Data obtained demonstrated the means to apply MLU as an assessment measure potentially available to provide evidence of the developmental levels of participants.

7.24. Measuring MLU in SV utterances

Using the protocol by Johnson (2005) as described above, samples were scrutinized for all participants, using 10 SV utterances to reach an MLU total, subsequently divided

by the number of utterances. As with any utterance, word length and number of morphemes will vary from short, one word statements to longer, complex sentences. To capitalise on limited resources, the longest and most complex utterances for each individual participant were examined, assuming simpler forms to have been previously acquired. The sample below identifies the procedure.

Chapter 7 o sample

Researcher: When you go out on the minibus, tell me the best place to go

The park …… and swing/ing. 5 morphemes

I have my own voice 5 morphemes

Researcher: We get some very good sounds with you don't we?

Awesome, I said my name 5 morphemes

We must speak Rose 4 morphemes

I'd say that's right, I say it 7 morphemes

You would hear me talk/ing, marvellous 7 morphemes

Oh yes, go/ing to hear it 6 morphemes

Researcher: What colour is your jumper?

I have purple, was I correct? 6 morphemes

Have you finished, do you want to finish ?

Much more, I'll have more 5 morphemes

I need it perfect 4 morphemes

Thus, for Participant 16, morphemes in all the 10 utterances are counted as a total to equal 54.

Using the procedure identified by Miller (1981) as above, the total number of morphemes are divided by the number of utterances to establish the MLU

Thus for Participant 16: 54 morphemes divided by 10 utterances =5.4

Age Equivalent is established by reading off the MLU score against the tabulation established by Miller (1981) (See Figure 7.2) showing 57 months or 4 years 9 months. The procedure for establishing MLU and Age Equivalent was applied to all participants.

As seen in Table 7.4 below, the expectation that individual outcomes would stay within 0- 5years (60 months) proved to be misleading and 16 participants achieved scores in advance of those anticipated for children during the early years. Where individuals achieved scores outside the range associated for MLU of pre-school children, they also therefore exceeded the Age Equivalents referenced by Miller (1981.) The table below presents the outcomes, with only 4 individuals achieving Age Equivalent scores below 60 months.

Table 7.4: The MLU scores and Age Equivalent for all participants

Participant	Total Morphemes in 10 Utterances	Age Equivalent In months
Participant 1	89/10	60+
Participant 2	87/10	60+
Participant 3	82/10	60+
Participant 4	61/10	60+
Participant 5	57/10	60+
Participant 6	53/10	57
Participant 7	71/10	60+
Participant 8	73/10	60+
Participant 9	59/10	60+

Participant 10	72/10	60+
Participant 11	85/10	60+
Participant 12	55/10	57
Participant 13	73/10	60+
Participant 14	84/10	60+
Participant 15	52/10	54
Participant 16	53/10	57
Participant 17	73/10	60+
Participant 18	72/10	60+
Participant 19	67/10	60+
Participant 20	66/10	60+

See Appendix XXI Samples of morphemes in participant SV sentences

7.25. Strengths and limitations of MLU

MLU was developed to measure language acquisition in pre-school children and therefore offers scope for participants who are developmentally within this range, if not chronologically. It is an easily applied assessment, where only SV language samples are needed to evaluate competencies. As long as individuals produce utterances, no more is required, thereby circumventing the difficulties in assessments that require observable behaviours that cannot be carried out by individuals with physical and/or sensory impairments. However, it must be borne in mind that the quality of the samples of atypical phonation may mislead, particularly with regard to correct transcription of plurals or tenses. Due to the difficulties in obtaining clear samples of SV utterances, a margin of error may occur. For example, interpretation of “have,” or “had,” or “shoe,’” or “shoes,” can be problematic, adding or removing morphemes from the total counted. MLU may therefore offer an approximate rather than precise estimate of the content of utterances.

MLU is recognised as appropriate and suitable for use with both normal and learning

disabled children, facilitating comparisons between normal language development and language used by individuals designated PMLD. As with developmental milestones, described above, where participants exceed the developmental range encompassed by the MLU assessment, recourse to more advanced measures would be required.

7.26. Results of MLU assessments

Comparison of SV utterances against standard measures of MLU clearly demonstrated linguistic abilities above that commonly attributed to the participants as PMLD individuals. MLU provided direct comparison with normal language levels such that SV utterances for all participants were shown to have language equivalent to normal stages above 24 months. For some participants, language met descriptors for 5 year old children and possibly beyond (with further assessment.) Although these results reflect data from a limited number of samples, they nevertheless provided evidence contrary to the generally accepted view of PMLD people as pre-linguistic, operating within the developmental stages of infancy. Comparison with language levels in normal children showed that the participants had, or were, moving through the developmental stages associated with normal language acquisition above the developmental period of 0-24 months.

7.27. Language rules and conventions

In addition to content of an utterance, meaning is conveyed in language by processes and conventions underpinning how the language is used. Such processes operate

both to facilitate interpretation and to ensure communicative function between two or more partners in an interaction. The third purpose of this study was to identify in utterances the ability of participants to demonstrate adherence to the rules and conventions that underpin how language is used. Specifically, the use of intonation and turn taking were considered.

7.28. Method for assessing language rules and conventions

Utterances were scrutinized for evidence of prosody and turn taking. Linblom et al (2014) Ashby and Maidment (2005) and Ladefoged (2005) emphasise the importance of prosody in facilitating meaning beyond that of the individual word. Using pitch and intonation, prosody signals the intent of the utterance – excitement, disbelief, a question, command, or statement for example. Prosody can also convey the speaker's emotional response.

An additional element of SV utterances that provided evidence of the relationship between SV utterances and normal dialogues lay in turn taking processes. In order to ensure joint focus of attention and language as a communicative dialogue, turn taking is required. Demonstration of the ability of participants to recognised and use this convention added to the weight of evidence that SV utterances were meaningful and participants were linguistic. .

7.29. Prosody

Surprisingly, SV utterances included the use of appropriate prosody, demonstrating

that, despite their inability to use utterances as audible speech, participants mapped their own language performance upon the rules and conventions typical in normal speakers around them. The reasons for doing so were not clear, as the inaudible nature of utterances belied the purposes underpinning prosody in language. That participants incorporated prosody in SV utterances, showed an awareness (and use) of the rules and conventions in language, even though they had not applied this in audible speech. Their ability to do so added weight to the proposal that SV utterances were meaningful.

Participant 2 swears when the researcher tells him they will record his SV voice. His intonation appears to be dismissive and disparaging, doubting the authenticity of her statement

Chapter 7 p sample

Participant 2: This is rubbish, this is shit.

Participant 11 and Participant 13 express excitement/surprise when first hearing playback of their SV utterances

Chapter 7 q sample

Participant 11: Talking back, oh Christ

Participant 13 : Oh wow, my voice!
Yes! It's so lucky.

7.30. Turn taking

Keitel and Daum (2013) and Yoo et al (2018) acknowledge the universal nature of turn taking as an integral part of language and communication, occurring in normal infants both before and during the early development of language.

Participants maintained turn taking protocols, apparently deferring to the researcher as 'senior' partner in the dialogue, but clearly understanding and using the convention of taking turns in joint exchanges. Sub vocal phonation, in the current study, operated as a dialogue where the participant and the researcher did take turns, with the participant responding to the researcher. However, as the SV utterances were inaudible before amplification and processing, the researcher did not respond to the participant in real time. There was a delay as the participant's dialogue was recorded, amplified and then replayed in order for the researcher to respond directly to the participant's comment/s. However, during recordings, the failure of the researcher to respond immediately to the participant did not disrupt the exchange. Instead, the participant spoke sub vocally (and therefore inaudibly) in response to the researcher then awaited the next comment by the researcher, even though the participant's previous contribution may have been ignored. When the researcher spoke again, the

participant responded again. Anticipated problems in the turn taking processes that regulate the exchange were not compounded by the inability of the researcher to hear the participant's responses. The participant could and did maintain the communicative exchange using normal turn taking procedures. Notwithstanding the complexities arising from the inaudible nature of SV utterances , the ability of participants to adhere to turn taking protocol , despite the difficulty for the researcher in doing so, were consistently demonstrated, so that the 'normality' of the dialogue was reinforced.

Two participants demonstrate turn taking dialogues. Participant 15 (one of the youngest in the cohort at 3 years old at the start of the research) maintains turn taking. So also does Participant 1, the oldest in the cohort , answering questions from the researcher.

Chapter 7 r sample

Researcher: I can hear your voice

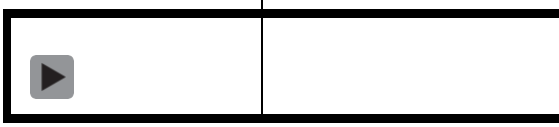
Participant 15: It's something that I can, wonderful

Researcher: Clever boy.

Participant 15: I was.

Researcher: Talking nicely

Participant 15: I was



Researcher: Can you tell me the name of a famous painter?

Participant 1: Picasso was fabulous

Researcher: Can you tell me a breed of dog?

Participant 1: I can't really

Researcher: What's my dog called?

Participant 1: It's called Luke. It's a silly name

Evidence that participants understood and used turn taking appropriately were also supplied by utterances produced during periods when participants were invited to 'Say whatever you want to,' for a specified period of time. During these interludes, participants continued unabated, clearly aware that they need not pause or wait for the researcher to speak. Their understanding of when and when not to insert pauses was evident.

7.31. Social etiquette

As well as intonation and turn taking, participants included normal courtesies in their exchanges with the researcher mapping their utterances on normal patterns of social etiquette. They all knew to use 'Please' and 'Thank you,' although they had obviously never been required to do so for inaudible utterances. They also apologised when they thought it necessary to do so. Participant 12 and Participant 8 express their appreciation of their recording sessions.

Chapter 7 s sample

Participant 12**:** Thanks

Thank you I can talk

Researcher: Have you been talking today?

Participant 8: I have .

Super.

Thanks

Participants also recognised some words were inappropriate, apparently recognising swear words or responses they thought might offend the researcher. When these occurred, participants indicated their awareness of the unsuitable nature of their comments. They clearly recognised social proprieties.

Chapter 7 t sample

Participant 2 : I'm in trouble when they hear (swearing)

Participant 11: Rosie heard that (swearing)

Participant 14: Sorry for the comments. Gosh

7.32. Language as an intellectual measure

Study 3 was also intended to demonstrate knowledge and understanding developmentally beyond 0-24 months in SV utterances. In recording, reporting and describing the linguistic stages evident in the content of SV utterances, it became apparent that sub vocal utterances also offered a potential means to identify cognitive and developmental levels of intellectual ability beyond 0 – 2 years. Using SV utterances, participants could tell the researcher what they knew and understood in ways that revealed linguistic and cognitive competence, despites the limitations of physical and sensory impairments that inhibited other forms of assessment.

In dialogues with the researcher, or in spontaneous utterances, previously hidden knowledge and understanding became apparent. In particular, by inviting responses to targeted questions the researcher obtained insight into general knowledge acquired by participants, indicative of their previously unrecognised intellectual and cognitive abilities. As with language acquisition, access to SV utterances enabled the identification and evaluation of participant abilities not otherwise demonstrated and not anticipated in this population.

In asking questions, participants were told always that the answer was of interest to the researcher, but not important. This was to ensure that the children and young adults were not under pressure to respond and should simply say ‘I don’t know’ if they did not. However, participants clearly liked to show their competence and did so proudly.

7.33. Setting the questions

As learners designated PMLD do not have access to a mainstream curriculum, questions by the researcher drew on everyday experiences at home and school or college. Questions therefore reflected what might have been learnt in special education or in experiences at home. Nevertheless, the researcher did not make concessions to the presumed developmental delay attributed to this population, but instead structured questions to elicit responses reflecting general knowledge more applicable to older children (5-6 years) extracted from General Knowledge quizzes (https://quizzykid.com/quiz/easy-general-knowledge-quest) In addition, questions relating to everyday experiences or everyday media news were included.

Participants were asked to identify days of the week, in order, and to identify where days fell in relation to each other.

Chapter 7 u sample

Researcher: Can you tell me what day it will be tomorrow? (asked on a Wednesday)

Participant 12: Thursday

Researcher: If it were Sunday today, what would the next day be?

Participant 11 Monday

Participants were asked about numbers

Chapter 7 v sample

Researcher: What's five and seven ?

Participant 12: Twelve

Researcher: Can you tell me five add five?

Participant 7: Ten

Researcher: How many pennies in a one pound coin?

Participant 1: A hundred

Researcher: Can you add up ten and five

Participant 8: Fifteen.

Participants knew their colours.

Chapter 7 w sample

Researcher: What colour is your jumper?

Participant 16: I have purple

Researcher: Can you tell me what colour that is? (Shows yellow paper)

Participant 7: That's yellow colour

The researcher also presumed that participants were exposed to media sources at home, potentially offering opportunities to acquire knowledge and understanding

tangentially, if not intentionally. One mother explained that Radio 4, discussing political issues was always played during the morning before school. In addition, carers and families talked among themselves, exposing participants to a wide range of subjects and interests, presumably unaware that their comments would be heard and understood by them. Consequently, although they may not have been directly taught, general knowledge questions were used to invite participants to tell the researcher what they knew about the world around them.

Participants demonstrated their awareness of figures in public life as below:
Chapter 7 x sample

Researcher: Can you tell me who the Prime Minister of England is?

Participant 1: David Cameron (2015)

Can you tell me who the Prime Minister is?

Participant 7. Let me think….Theresa (2018)

Do you know the name of the Prime Minister of England? (2018)

Participant 18.Theresa May (2018)

Researcher: Do you know about the American election?

Participant 8: They have elected a madman called President Trump

What's the name of the Queen's husband?

Participant 11: Philip, yes

Some participants clearly heard national news, explaining what they understood about politics. That they paid attention to what they heard suggests a degree of interest in subjects that would not normally be considered of concern to the population designated PMLD. Parents more commonly reported playing TV programmes such as Teletubbies or Disney channel to their children.

Chapter 7 y sample

Researcher. Can you tell me what Brexit is?

Participant 2: Out of Europe

Researcher: Tell me what Brexit is.

Participant 8: They're leaving …..Europe. They'll find we'll leave

It was apparent (by checking with teaching staff) that participants had not addressed issues concerned with American politics or Brexit at school or college, although the subjects may have been the focus of discussion by the adults around them at home or in educational settings. Knowledge of the election of President Trump and of Brexit suggests an ability to learn from exposure to information and facts, without specific teaching. This, in conjunction with their acquisition of language indicates a proficiency beyond that of an infant.

Participants demonstrated an awareness of geography.

Chapter 7 z sample

Researcher: Do you know what country you live in?

Participant 10: I live in England

I live in Hertfordshire.

Researcher: Do you know what is the capital of England?

Participant 10: London

Researcher: **Can you tell me the name of England's capital city?**

Participant 1: London, where the submarines are built in America.

N.B. London, Philadelphia, USA is America's primary East Coast submarine base

SV utterances identified general knowledge and awareness of the world. Participants clearly understood the questions and were able to tell the researcher what they knew and understood. Utterances provided clear evidence of knowledge and understanding of the world around them as well as demonstrating their use of meaningful SV language. Perhaps more importantly, the ability of participants to respond to questions offered a precise assessment measure, providing the researcher with the opportunity to ask individuals about any issue. Their willingness to respond with SV language overcame a range of difficulties inherent in assessments that required verbal speech or physical action on their part.

7.34. Summary

The aim of this chapter was to show that language used by participants in SV utterances was developmentally and linguistically beyond that anticipated during Infancy, presumed to be applicable to individuals designated PMLD. The chapter reports the application and results of 3 commonly used measures for normal and learning disabled children to identify the linguistic nature and level of SV utterances. Outcomes identified that all participants used language beyond 0-24 months , including appropriate vocabulary and grammar, meeting targets itemised in assessment measures. Although varying between participants, assessments clearly

identified that all participants operated linguistically and developmentally in excess of 0 -24 months, clearly above that of an infant.

Samples of SV utterances used in dialogues with the researcher also provided evidence of the use of intonation and turn taking, thereby showing the ability of participants to adhere to recognised rules and procedures that underpin language. Evidence of turn taking and prosody provided an additional source of data that demonstrated subtleties of language, integral to linguistic performance. Contrary to the current understanding of their abilities as profoundly developmentally delayed (Cunningham, 2016., Imray, 2005., Mansell 2010,) and pre-linguistic (Bellamy et al, 2010; Imray, 2005; Mansell, 2010; Nind and Hewitt, 2005; PMLD Network, 2016; Routes for Learning, 2006; Samual and Pritchard, 2001) the participants demonstrated linguistic competence sub vocally and could and did produce utterances using the same rules and conventions that typify normal language use at developmental levels above that of infancy. The participants were not pre-linguistic and could produce utterances using the same rules and conventions that typify normal language use.

Lastly, a range of question and answer sessions demonstrated knowledge and understanding of the world around them. Participants were able to answer a variety of questions that revealed learning that had not been anticipated, much of which appeared to have been acquired incidentally, rather than by specific teaching. Their ability to do so identified competence above that of an infant and further confirmed their meaningful use of SV utterances. The nature of their comments, particularly in response to those of the researcher demonstrated that their utterances were occurring appropriately and correctly within a context that offered precise evidence of their ability

to both understand and respond with meaning. Moreover, their awareness of the world around them, and particularly of information reported via media sources, indicated their ability to learn tangentially rather than via specific teaching. This is impressive in individuals assumed to operate at sensory motor levels. Their knowledge of political figures and events surprised both their teachers and families yet revealed that participants were capable of understanding and assimilating far more than had been supposed. Further research is needed to identify the nature of their learning skills in order to provide appropriate teaching strategies, but evidence of their knowledge belies the expectation that their understanding and capacity for learning is profoundly compromised.

CHAPTER 8: Phase 4 :

8.1. Introduction

Phase 4 addresses the research question:

Are the SV utterances produced by the research participants meaningful?

Phase 4 used a qualitative methodology to assess the meaningful nature of SV utterances produced by the 20 research participants. The SV utterances were produced by all 20 participants and were selected on the basis of the acoustic quality of the recordings and the meaningful nature of the content.

Phase 4 was designed to explore the ability of the research participants to use SV utterances 'meaningfully.' In Phase 4, 'meaningful' is applied to three definitions as below:

- The Oxford Dictionary (2008) definition of meaningful as 'significant, important, relevant, valid, purposeful.
- Contextually appropriate

Meaningful utterances are specified as intentional, coherent and contextually appropriate. They are not random, indiscriminate or unplanned. Utterances have 'meaning' by their relationship to the situation in which they occur. Thus, to be meaningful, research participants are required to demonstrate their ability to use their language intentionally, in contextually appropriate ways that show their

deliberate and purposeful intent. Thus, in responding to interview questions, answers must be clearly related to the question asked.

- Using abstract concepts including views, opinions and ideas

Meaningful as an abstract concept where abstract is a thought process where ideas do not physically exist and are distinct from objects. Utterances therefore have meaning by incorporating abstract concepts.

8.2. Current knowledge

Due to the absence of research studies into the ability of individuals designated PMLD to produce SV utterances, as identified in the literature review, a corresponding lack of studies into the meaningful nature of their utterances was also apparent. However, a current debate and discussion regarding issues of self advocacy, and the means to enable PMLD individuals to contribute meaningfully to plans and decision effecting their own lives (Clarke and Moss, 2011., Mansell, 2010., Ware, 2004) provided parallels with the research question about the meaningful nature of the SV utterances used by the research participants.

Currently, researchers in the field of PMLD studies question the ability of people designated PMLD to produce meaningful communication (Cea and Fisher, 2003., Cummins, 2002., Felce, 2002) as defined above due to:

- The pre-linguistic status of their communication , that is they have not acquired

language.

- The pre-intentional nature of their communication, that is, they do not intend to communicate.

- The pre-linguistic and pre-symbolic nature of their communication, lacking symbolic representation and abstract thinking in association with their pre-linguistic status.

In contrast, despite the present understanding that PMLD people are pre-intentional and pre-linguistic in conjunction with their inability to formulate or express views, opinions and ideas symbolically, the research participants were invited to produce meaningful responses to demonstrate their linguistic acquisition at a level where abstract concepts could be formulated and expressed intentionally and linguistically.

Consequently, Phase 4 was designed as a series of semi structured interviews within which to gather data to show the meaningful nature of participant SV utterances, meeting the definitions above. Semi structure interviews were therefore planned with the focus on the participants' experience and use of SV utterances, a subject shared by them all. Additionally, in research studies, qualitative data offers the means to enhance and supplement the quantitative data pertaining to the research hypotheses (Densombe, 2008., Morse, 2003). This approach, facilitated the design of Phase 4, where inclusion of participant responses in semi structured interviews could also demonstrate the quantitative outcomes of intelligibility explored in Phase 2 and the

developmental and linguistic levels explored in Phase 3. Further, by focusing interviews on participant SV utterances, the researcher had the opportunity on draw on their knowledge and experience to explain and describe the phenomenon by those best placed to do so.

8.3. Rationale for semi structured interviews

In order to ensure that information elicited from participants was more than a haphazard collection of comments, the study was designed to adhere to recognised good practice in qualitative interviews. Exchanges with participants needed the organisation and structure of a definitive framework. Procedures integral to semi structure interviews offered the recognised methodology of a qualitative approach within which data could be gathered and organised. Furthermore, Boxall and Ralph (2009) report the problems in including PMLD individuals in research studies, often excluded due to issues of informed consent and the increased regulation around legal and ethical requirements. The presumed inability of people designated PMLD to contribute meaningfully has been acknowledged as a barrier to their inclusion (Cea and Fisher, 2003., Cummins, 2002., Felce, 2002) In Phase 4, semi structured interviews could ensure that the participants designated PMLD would be included and able to demonstrate their meaningful contributions.

Interviews also gave a ‘voice’ to participants endorsing their rights to contribute their ideas, opinions and views to the knowledge generated by the quantitative data gathered for the research. (Marshall and Rossman 2006,) In addition to the demonstration of the meaningful nature of their utterances, the opportunity to contribute to the research could empower participants, recognising their abilities to

express their own thoughts and attitudes in their own SV language. For individuals for whom this option had not previously been available, the opportunity to do so was apposite.

The use of semi structured interviews are recognised as the means to provide the organisation and structure of a definitive framework (Polkinghorne,2005., Robson 2002., Schwandt 2001.) largely made up of open ended questions (Boyce and Neale, 2006., Jacob and Ferguson, 2012.,) to which participants could respond as they chose. Within these parameters, Polit and Beck (2012) remind the researcher of the need to ensure accurate representation of the data, reporting what the participants conveyed rather than the interpretation assumed by the interviewer. Various perspectives may not converge, particularly between that of the researcher and the participants. Caution in developing unwarranted inferences was necessary, to ensure participant contributions were not misrepresented, especially where the participants had limited opportunities to further explore the researcher's understanding. This could occur where participants might be constrained in their opportunities to record their responses (entirely dependent upon the researcher's provision of time and equipment) with additional difficulties in ensuring that the quality of recordings facilitated correct transcription.

8.4. Method

Semi structured interviews were conducted during recording sessions, where the research participants responded to comments and questions by the researcher and spontaneously contributed their own extended observations. Due to the one way exchange whereby the researcher could not respond immediately to the participant's

contribution, even if the thrust of the interaction was intended to explore specific issues introduced by her, participants invariably contributed their own additional comments and observations. Moreover, this approach facilitated the introduction and development of topics by participants on many occasions, expressing their abstract views and opinions. . Due to the respiratory limitations for many of them, recording sessions were of necessity short, so that these exchanges were best spread across a number of sessions thereby allowing participants to be at their best on each occasion.

By ensuring reference to the framework of an interview, the researcher's approach also acknowledged that various perspectives may not converge, particularly between that of the researcher and the participants. The researcher's interpretation of the experiences of participants needed to take account of their views and opinions. Caution in developing unwarranted inferences was necessary, especially because of the lack of supporting data in the corpus, where prior exploration of the phenomenon of SV utterances by this population is conspicuously absent. Polit and Beck (2012) remind the researcher of the need to ensure accurate representation of the data, reporting what the participants conveyed rather than the interpretation assumed by the interviewer. Thus, opportunities for participants to contribute to the research were seen as a means for the researcher and participants to achieved shared understanding of a chosen topic, working collaboratively to extend, probe and clarify issues of interest. Eliciting their contributions provided a coherent context within which the researcher and the participants could explore their experiences with regard to SV utterances, thereby producing a completer and more comprehensive picture than might otherwise be available.

A particular advantage of gathering content from participants to illuminate the research was the efficient use of resources as advised by (Marshall and Rossman, 2006.) During exchanges with participants the researcher could gather recorded data for different aspects of the research concurrently, subsequently separating those elements of the recordings into constituent parts, applicable to data reflecting participant perspectives or to other areas of the research study. .

8.4.1. The role of the researcher

Francis et al (2009) remind the researcher that efforts to elicit the perceptions and experiences of the participants of a given phenomenon is a valuable means of gathering data, but attention must be paid to the role of the researcher and her relationship with the participants. Rossman and Rallis (2003) too propose that research involves issues of power, where the personal status, race, class, gender and social identity of the researcher impinges on the relationship with the participants. In this study, the unequal nature of the relationship between participants and researcher was a consequence of her power both as a professional adult and her role in controlling recordings. Additionally, the interests and concerns of the researcher were with the research. In contrast, those of the participants often reflected their interests in communicating their observations on issues of personal interest, but not necessarily pertinent to the research hypothesis. However, because the researcher structured the exchanges with participants, asking questions or contributing comments reflecting her research, the focus of the researcher might have prevailed in almost all instances. Moreover, participants (perhaps due to the educational settings in which recordings were generally made) appeared to be ‘respectful’ towards the researcher. They responded as requested, generally waiting for the researcher to finish speaking and

to offer a recording opportunity, answering questions and using courteous responses of ‘Please,’ and ‘Thank you.’

Although participants usually appeared to attribute authority to the researcher in recording their utterances, the researcher sought to reciprocate with reassurance and respect. By replaying and praising their recordings, their efforts could be valued. In addition, the researcher sought to be honest with participants, acknowledging when SV phonation was good, but also explaining when SV phonation was insufficient to achieve a good result. Similarly, views expressed by participants were acknowledged to them as sensible and valuable. Confidentiality was respected too, if participants asked that it be (although safeguarding issues could not have been.) However, in some cases, participants were insufficiently mature to recognise what should or should not be shared with others, and the researcher made that judgement, particularly where issues related to the private life of parents and/or family life.

Despite the (often inadvertent) controlling role of the researcher, participants were always invited to contribute spontaneously, to say whatever they wanted to say, for a minimum of 1 minute and a maximum of 14 minutes. This ensured that participants could express their own views and opinions on subjects of their choice, albeit dependent upon the quality of the recording to ensure adequate transcription. Although opportunities to produce spontaneous utterances did not always relate to issues relevant to the research, the right of individuals to use their own vocabulary and their own choice of subject was respected. Moreover, a flexible approach to gathering participant contributions were seen to be of benefit in the structure and implementation of exchanges with them. To ensure that participants would not feel that particular

responses were expected, questions were formulated using ‘open’ terminology that did not suggest required answers. Questions were generally prefaced with ‘What do you think about……?’ or ‘Tell me about……’ ‘ Cues that might have influenced responses were avoided and there was no effort to imply a right or wrong answer. At the end of the session, participants were thanked and praised for their contributions.

8.4.2.. The structure of the exchange

King and Horrocks (2010) consider that the traditional means of structuring an interview using a fixed order of pre-set questions may inhibit rather than expand participant contributions. Instead, they advocate the need for flexibility in the use of a qualitative interview, to enable respondents to move in directions not necessarily anticipated. This approach was adopted in exchanges between the researcher and the participants, particularly in acknowledgment of the many unknown aspects of the phenomenon of SV utterances by people designated PMLD. Individuals currently using this form of phonation were obviously well placed to identify areas as yet unknown and unexplored. In addition, the researcher too had the freedom to be responsive to emergent issues of importance to the interviewee, rather than a set schedule that might miss something of significance. King and Horrocks (2010) therefore suggest the use of an ‘ guide’ containing the main topics to be considered while the format and order of questions are amenable to variation. Consequently, a guide was designed to denote areas to be explored.

8.4.3.. The guide

The guide (See Appendix XXll) set out areas to be explored in order to maintain focus

in the exchanges yet ensure sufficient flexibility in the procedure for participants to express their own meaningful views, opinions and ideas. Some potential follow up probes or content mining as proposed by Legard et al (2003) were included, assuming that they would be appropriate to participant responses. Due to the inability of the researcher to respond immediately to SV comments, the opportunity to amplify and process the initial comments following recording allowed time for her to consider how best to respond subsequently. The guide was therefore, a flexible framework yet there to remind the researcher of areas of particular relevance to the hypothesis while exploring with participants their own awareness of and response to the demonstration of their meaningful (amplified) utterances. Therefore, in developing the interview guide, the researcher related questions about participant perceptions to the research questions, seeking association between the questions and responses that offered data supporting the proposal that SV utterances were meaningful. Moreover, responses also contributed data in support of Phase 1, Phase 2 and Phase 3. Audio samples could be crossed referenced to Phase 1, where acoustic analysis looked for features in utterances parallel to those in normal speech and whisper. Interview questions elicited responses that demonstrated intelligibility (examined in Phase 2) and developmental levels (examined in Phase 3) in addition to views, opinions and ideas, offering support to all phases of the study.

Kallio (2016) in a methodological review of semi structured qualitative research papers offers a framework for the development of a qualitative semi-structured interview. This included Step 1 and Step 2, acquisition of previous knowledge about the subject area, Turner (2010) advises reference to previous knowledge to determine an interview framework, while Rabionet (2011) advises the need for the researcher to provide a

good grasp of the substance of current knowledge Where knowledge is fragmented or sparse, (as with SV utterances by PMLD participants) Krauss et al. recommend consulting experts able to describe the phenomenon but , due to the lack of awareness of SV utterances by participants designated PMLD, there is a lack of previous knowledge or expect help that could be called upon. Methodological guidance from other qualitative research studies using semi structure interviews was available and offered direction (Krauss et al. 2009., Cridland et al.2015) but reference to experts for previous and current subject knowledge was not possible as the phenomenon of SV utterances by individuals designated PMLD was not identified in the literature.

Step 3 as advocated by Kallio (2016) is formulating the interview guide. (See Appendix XXII) The aim of the guide was to gather data reflective of the interviewees' own spontaneous, personal views and opinions. Accordingly, the questions were determined before the interview as recommended (Mason, 2004., Rubin & Rubin, 2005., Taylor, 2005) then structured as a list, as identified by Whiting (2008) and Krauss et al.(2009) that focused on the research topics. The procedure was planned to maintain a focused structure for the interviews in order to collect comparable information from each participant (Holloway & Wheeler, 2010), by guiding but not leading the discussion. Although seeking consistency integral to the research areas, participants would be able to expand on their comments or to extend answers in directions of their own choosing. However, follow up questions by the researcher were devised to follow main questions but the inability of the researcher to hear participant responses in real time inhibited any spontaneous follow up questions by her in response to unexpected comments made by interviewees during recordings.

Kallio (2016) reports Stage 3 in the development of an intended interview to be a pilot test to confirm the relevance and subject matter of the content, and to allow appropriate changes and adjustments. Such a pilot test would use a small number of participants similar to those who are the intended interviewees (Maxwell 2013) Due to the lack of PMLD individuals using SV utterances (other than the research participants) a pilot test with a similar population was not feasible, but some field testing (Krauss et al.2009, Turner 2010)) was undertaken with 5 of the participants to test the extent to which similar questions could usefully elicit their views and opinions (Chenail 2011) However, participants were not asked to comment on the questions included in the interview guide as their spontaneous responses in the real interview were sought, not to be pre-empted by prior experience. Nevertheless, the pilot test clarified details about presentation of the interview including the length of time to be made available for participants to respond and the order, number and content of questions necessary to elicit and demonstrate meaningful responses.

In addition to the pilot test with 5 participants, the interview guide was tested by the researcher and one of her colleagues. Chenail (2011) advises that where pilot tests are not easily undertaken, the researcher should herself be interviewed, thereby identifying any researcher bias and gaining an insight into the experience for the research participants, particularly with regard to any ethical or sensitive issues to be considered. Accordingly, the researcher was interviewed by a teacher at one of the educational establishments where the research was undertaken. Further discussion, consideration and adaption of the research questions resulted, in particular the inclusion of interview questions seeking opinions and views from participants about the acquisition and development of their language. Additionally, the interview

questions were considered by one of the research supervisors who commented on the wording and structure of the questions, providing an expert consideration of the suitability and appropriateness of the interview guide.

8.4.4.. Construct validity

In developing the interview guide, the substance was appraised for construct and content validity.

Construct validity is described by Polit and Beck (2012) as the degree to which a test or assessment measures what it purports to measure. Thus, in developing an interview guide to demonstrate the meaningful nature of SV utterances it was necessary to ensure that the interview guide was sufficient to ensure this outcome could be achieved. Consequently, relevant questions in the interview guide were set to be directly applicable to the research question, providing interviewees with the opportunity to articulate and express responses that met the above criteria for 'meaningful.'

Smith (2005) considers that construct validity is also measured by the extent to which the measurements used can test the theory or hypothesis from which it arises. Although this research is not driven by a recognized theory, the intended interview questions were representative of the hypothesis concerning the intelligibility, linguistic and developmental levels of the participants, potentially demonstrated by their responses. In addition, Smith (2005) advises that, where proven theory or an acknowledged measurement is absent, repeated evidence can replace both, even where the hypothesis is still unproven, as in this case. The intended collection of

recurrent responses from all participants offered a means to replicate and repeat evidence, gathering a range of data, representative of them.

Accordingly, the guide developed by the researcher set out areas to be explored in order to maintain focus in the exchanges yet ensure sufficient flexibility in the procedure for participants to express their own views, opinions and ideas, demonstrating their abilities to encompass past, present and future issues. Some potential follow up probes or content mining as proposed by Legard et al (2003) were included, assuming that they would be appropriate to participant responses. The guide therefore offered a flexible framework yet there to remind the researcher of areas of particular relevance to the hypothesis while exploring with participants the meaningful nature of their (amplified) SV utterances.

8.4.5. Content validity

Content validity is concerned with the extent to which the interview captures the most relevant and important aspects of the concept under discussion, supporting the inferences that can be drawn from the collected data. Essentially, the interview questions were designed to facilitate the contribution of participant views, opinions and ideas about their use of SV utterances, demonstrating the meaningful nature of their SV responses. Bond et al (2009) and Lasch et al(2010) advise that content validity for the interview guide can be obtained using the participants in conjunction with experts to act as informants. The participants have personal, first hand experience to contribute while expects such as researchers can provide an outsider perspective due to their experience with different situations and different individuals. Accordingly, the interview guide was shared with teachers and education staff as

described above and participants were asked to consider if they thought interviews about their SV utterances would be a useful and appropriate measure. It is important to recognize that participants included children as well as young adults, so that the appropriateness and usefulness of the interview was presented to them as the opportunity to talk about their experiences in using SV utterances in recorded forms that were familiar to them. All participants were happy to do so.

8.4.6. The limitations of the exchanges

Despite the advantages of structuring exchanges with participants using the framework of an interview approach, any interchange between the researcher and participants was not a conventional interview due to the inherent constraints on a dialogue where the researcher could not access the participant's responses immediately. Responses had to be amplified, processed and transcribed, a procedure that could suspend the on-going exchange for whatever period of time was required. Participants were told about the constraints on the researcher but despite this, they responded to her questions and comments, to provide a wealth of data upon which the study could draw. In response, efforts by the researcher to ensure adherence to commonly acknowledged good practice in interviews enhanced the value of the data, placing interview responses within a meaningful and recognizable framework.

The inaudible nature of participant responses also had the potential to disrupt individual contributions if the researcher spoke over the SV voice of the participant, unaware as she was of when they were or were not producing utterances. Similarly, contrary to common practice in interviews, where pauses often function to identify the intention of the respondent to extend his or her answer, pauses were not subject to

the management of the interaction by the researcher. Unable to hear the participant's SV utterance in real time, the researcher was not aware until subsequent transcription when pauses were or were not employed. Evidence of the ability of participants to do so was provided subsequent to an exchange. Opportunities to support or encourage participants to extend replies were random rather than intentional, encouraging participants at intervals with general 'Ah ha' or 'OK' comments to indicate that she was still attentive and listening. Consequently, long pauses by the researcher were not unusual and had the advantage of enabling participants to extend and develop their comments, often dependent on recuperating respiratory energy before continuing.

Some difficulties were apparent due to the physical and sensory impairments of the participants, Strategies commonly employed in joint interactions such as smiling or nodding, responsive body language or facial expression were generally absent in participants. Where employed by the researcher, they may not have been readily apparent to the participants due to their visual impairments. Nevertheless, the tone of voice used by the researcher sought to convey encouragement or interest during the exchange. Comments by participants were acknowledged and valued, albeit subsequently rather than immediately. Thus, although exchanges lacked some of the elements conducive to productive face to face conversations, they retained the essential features more common to long distance exchanges such as telephone interviews, so that data could be collected successfully with patience and persistence on the part of both researcher and participant.

Despite the difficulties inherent in an exchange where the responses of one partner are delayed and features common to normal conversation lacking, every effort was

made to sustain a structure, seeking to ensure the credibility of the procedure. Reliance on interview procedures to guide and shape interactions meaningfully, rather than undertaking a simple ‘chat’ with individuals ensured a focus on the purpose of the exchange to gather relevant data in a meaningful way.

8.5. Interview procedure

Robson (2002) offers guidance on interview procedures, including an introduction and warm-up prior to the introduction of the main questions, followed by a cooling off exchange to resolve any tensions that might have occurred. In this research, exchanges with participants were most generally inserted into on-going recording sessions where participants were already contributing, comfortably and relaxed. Due to the on-going nature of the investigation, participants were already familiar with the procedures and the researcher and already knew and understood the purpose of the research. However, recording sessions started with a ‘warm up’ asking participants ‘Do you want to do some recording today?’ This was to reaffirm the agreement of individuals to record and to be sure that they felt happy and well enough to continue. Next, the researcher and participant listened to the playback of those SV utterances recorded in the previous session if quality of the recording was sufficient. This facilitated follow up points if any were evident and gave the researcher the opportunity to acknowledge and value the contribution made. Open questions or comments were then introduced. Although data collected in interviews may require only one session, for this research exchanges were spread over a number of sessions for each participant. This was because of the need to limit the length of each recording session to ensure that participants were neither fatigued nor stressed for respiratory energy.

8.5.1.. The recording environment

Recording sessions took place in an empty room to ensure a quiet environment for the benefit of the recording procedure. Unnecessary noise was detrimental to the quality of recordings and therefore avoided whenever possible. Participants joined the researcher, accompanied by familiar staff or a family member. Participants were wheelchair users so already physically settled and comfortable with the added advantage of being able to relax and concentrate on the exchanges with the researcher. Many like to use the Sound Box system, enabling them to hear their own utterances as they produced them, but others preferred to use a standing microphone, held close to their mouth by the researcher to capture the utterances. The time taken varied between 1 and 14 minutes, dependent upon the responses of the participant, the time given usually associated with the health and well-being of the individual.

During the session, specific follow up comments from previous exchanges could be interjected appropriately, gathering information pertinent to the research hypothesis. At the end of the session participants were given time to ‘Say whatever you want to.’ This was seen as the cooling off period advocated by Robson (2002) and respected the right of individuals to comment on or talk about any issues of their choice.

8.5.2. Topics

The researcher used the interview guide in seeking evidence in support of the ability of participant to produce meaningful responses, but additional topics were also often raised by individual participants, particularly when producing spontaneous utterances

during the recording, or having been given time to ‘Say whatever you want to.’ Individual participants spoke about what was important to them. For example, Participant 3 needed to explore issues relevant to a meeting about her future placement after school, while Participants 20 and Participant 18 had on-going concerns related to health issues. Some topics were common to several participants too, for example bereavement issues following the loss of class peers. This area that had not been anticipated as of concern to participants but did in fact prove to be a major concern for individuals when class peers were lost. Bereavement comments are not reported in this paper, due to the obvious sensitivity of the subject matter, but it is important to note that participants expressed real concerns about their own vulnerability following the loss of peers with similar complex health needs. They also demonstrated the same distress and confusion commonly associated with bereavement, clearly identifying feelings of loss and grief.

Legard et al’s (2003) guidance to achieve breadth and depth by instigating a topic (content mapping) and exploring the interviewees responses (content mining) offered a framework to exchanges, although sometimes limited by the inaudible nature of participant responses that interrupted exploration of topics until the next, subsequent recording. Although topics could be revisited at later recording sessions, the immediacy of an exchange was often lacking and the original focus less sharp. Consequently, themes emerging from the exploration of particular topics often reflected a ‘broad brush’ approach, lacking finer detail or elaboration due to the difficulties identified above in conducting the exchanges between the researcher and participants. Nevertheless, topics, once instigated by participants could be further explored, probing for further responses and information

Despite the keenness of most participants to introduce topics of specific individual interest, participants responded to the researcher's intention to elicit opinions, views and ideas regarding their use of SV utterances and the impact upon them. This enabled the researcher to interpret and write up responses specific to the research questions. The framework of the interviews elicited the repetition of similar comments, ideas and opinions from different participants, indicating similar thoughts, patterns and concerns subsequently incorporated in themes and sub themes.

8.5.3. The data

SV utterances obtained in recordings of participants and the researcher comprised the data. Marshall and Rossman (2006) emphasise the need for the researcher to ensure that collection of qualitative data is efficient in use of resources and effective in gathering the required data. The use of recorded utterances in this study provided qualitative data as an immediate consequence of the recording, subsequently available for transcription, description and analysis – an efficient use of the limited time available. This process too, proved an effective use of resources, enabling the researcher to acquire a wide range of data pertaining to the views, opinions and ideas of the participants while also demonstrating the linguistic, developmental and meaningful nature of their' SV utterances.

Feagin (2002) proposes that data collection is influenced by the hypothesis that has motivated the study. The hypothesis that people designated PMLD can produce meaningful utterances clearly learnt itself to data collection that made use of and demonstrated that fact. Using data acquired during exchanges with them,

participants contributed qualitative data expressed via their meaningful utterances. Data therefore represented the multiple perspectives of all 20 participants, in preference to the use of sampling where the use of data from limited numbers of the research is analysed. This ensured that the accumulated data epitomized the population from which it was drawn, including all participants of which 9 were female and 11 male, with an age range from 3 – 20.

Although data collection focussed on participants' views and opinions about their SV utterances, the lack of an existing theory about SV utterances allowed consideration of the background and development of participant SV utterances, seeking information about when and how participants had developed the language now demonstrated in their amplified utterances associated with past events.

8.5.4. Managing the data

The inclusion of participant contributions to the study required organisation and management of the data. Initially, data was collated as recordings, so that outcomes were saved as sound files. The content of each recording was transcribed as a Word document, coded to match the sound version and saved into the personal folder of each individual participant. A wealth of material resulted that could have become overwhelming. On-going orthographical transcription (coded to match recordings) organised and reduced the workload and the potential complexity of large amounts of material. In the initial stages of the research, transcripts were printed to enable the researcher to become familiar with all the data, readily available for review. Relevant parts were highlighted and this enabled the use of spreadsheets to record and compare participant responses, but printed material was later moved into Word folders

for more efficient and organised management. Material was also limited by the quality of the recordings, so that utterances that were obscured in whole or part were not included, thus reducing the workload.

8.6. Data analysis

Data analysis was ongoing throughout the period of the research, occurring informally during feedback on recording sessions when recurrent patterns became evident. Transcription of utterances made during recording sessions was inevitably accompanied by some degree of analysis as the researcher sought to interpret the meaning in them. Moreover, the interpretation of the data was intended to be limited due to the uniqueness of the phenomenon central to the research and the consequent constraints on potential theory development. This enabled the researcher to acquire information directly from participants without the imposition of existing theoretical perspectives.

8.6.1. Thematic analysis

Investigation of data in qualitative research commonly makes use of thematic analysis to focus on reoccurring patterns within and across data sets, to facilitate interpretation of the contents. Van Manen (2011) proposes thematic analysis as a means to recover, order and manage the meaning represented in qualitative data. The purpose of the analysis is to detect significant patterns and to interpret the meaning integral to it. Consequently, thematic analysis as advocated by Braun and Clarke (2006) was seen to offer an appropriate means to analyse recorded data, guided by efforts to instil order in the wealth of material contained in participant SV responses

Although there are a variety of approaches to thematic analysis (Alhojailan, 2012; Javida and Zarea, 2016) Braun and Clarke (2019) consider reflective thematic analysis to be suited to questions related to people's views and perceptions, used in this study to be indicative of the ability of participants to use utterances meaningfully. Braun and Clarke (2019) offer a clear framework that provides a systematic approach that identifies an audit trail of how the analysis is undertaken. Braun and Clarke (2019) emphasise that each phase of the process is not rigidly ordered but rather 'tools' to guide the analysis. Consequently, the framework is not intended to be specifically linear, instead allowing flexibility in moving between phases although, in an account of the process undertaken for this research, they are reported in order.

See Table 8.1. below

Step 1: Become familiar with the data
Step 2: Generate initial codes
Step 3: Search for themes
Step 4 : Review themes
Step 5: Define themes
Step 6 : Write up themes

8.6.2. Phase 1: Becoming familiar with the data.

Due to the continued presence of the researcher during the majority of the recordings, familiarity with the data was facilitated by her continued transcription and use of the

recordings, frequently played back by her to staff, parents and participants. As printed copies were made of each transcription, additional notes and memo points were included as aide memoirs, enabling her to retain much of consequence.

8.6.3 Phase 2: Generating initial codes

Codes are described by Braun and Clarke (2019) as a single idea, represented by a segment of data and conceptualized as the building blocks of themes. To generate codes, all transcripts of individual recordings were scrutinized, using the initial verbatim transcripts of the recordings from which a list of codes was established. As advised by Braun and Clarke (2019) codes were labelled to reflect what was of relevance to the research question and were seen as flexible, evolving through the coding process. Braun and Clarke (2019) advocate coding as similar to grounded theory (Charmaz 2006) reflecting the understanding and interpretation of the meaning by the researcher, using thoughtfulness and creativity in consideration of the data. This approach was particularly appropriate for the researcher where participant responses were coded under broad themes where these emerged, to allow descriptive and explanatory versions to be formed, later revisited for further clarification. See sample Appendix XX111

8.6.4. Phase 3: Search for themes

Braun and Clarke (2019) propose that data analysis should identify, report and analyse important issues occurring as patterned responses relevant to the research hypotheses. As a result, similar responses were clustered together (as annotated résumés) to span emergent themes, brought together as coherent responses to the

interview questions. As the process continued, moving flexibly between the steps, additional pieces of data congruent with the identified theme or categories were allocated the same code to facilitate organization of the information. In some cases, where new themes emerged, readjustment of coding was required, as data originally attributed to an identified theme was more appropriately placed in another theme. Thus, themes and sub themes could be expanded with additional utterances or the initial interpretation reconsidered in the light of more content, enabling more categories to be identified if required. Where a sub theme emerged related to a specific feature of the main theme, the relationship could be acknowledged and the sub theme appropriately categorised. Themes and related sub themes could be mapped to ensure associated data was affiliated for further subsequent analysis. Accordingly, identification of themes and sub themes was a continual process, with intervals to review and reconsider content. This enabled key points raised by most participants to be identified, encompassing allied data. See Appendix XXIV

In defining themes and sub themes, it was necessary to understand the difference between the two. Braun and Clarke (2019) elucidate. While a theme represents a recurring, common pattern signifying a central concept, a sub theme is a specific element of that concept, or particular importance to the research. Thus, in a theme of ‘speaking,’ sub themes referred to ‘quality’ of SV utterances where participants queried what they perceived to be a difference between their SV phonation and that of normal speech. This was an important aspect of their perceptions of hearing their own audible SV phonation for the first time, illustrating an experience particular to them. Similarly, comments about the use of their ‘voice’ presented as a sub theme, where participants remarked upon the use of a voice, a faculty never previously heard

by them due to the inaudible quality of SV utterances. Their awareness that they had a 'voice,' remarked upon after hearing audible playback, suggested that their utterances had always been sub vocal and that they had been previously unaware of having an audible voice that others might hear (even though participants knew that they had internalised language.)

In a subsequent review of this approach, Braun and Clarke (2019) address the issue of 'data saturation' where the researcher continues forming themes until no new codes or themes are identified. They advise that efforts to achieve data, code or thematic saturation is contrary to the values and assumptions of reflective thematic analysis. Instead, it is important to recognize that meaning is generated via the researchers interpretation of the data, following and not determined by the data. Consequently, the number of data items, codes or themes remain subjective, and should not be determined prior to analysis. As a result, the researcher utilised a conventional approach to data analysis, exploring how different codes were related, looking for preliminary similarities in participant responses. Kondraki and Wellman (2002) advise that preconceived categories should be avoided so that names for them should evolve from the data. This was the case with the first broad theme, as codes came together, arising naturally in relation to the experience of 'speaking' and emerging in response to the researcher's invitation to talk about their production of SV utterances. The novelty of the experience of hearing their own audible utterances for the first time was common to all participants contributing utterances to the research. Generic responses emerged in relation to how individuals perceived the experience, presenting data that could be collated into a theme of 'Speaking.'

8.6.5 Phase 4: Reviewing themes

At the end of the initial search for themes, broad themes were emerging, with some still uncertain codes, retained for further consideration. As anticipated from earlier familiarisation with the data, participant perceptions about their 'speaking' were apparent, illustrating their responses to hearing their own audible voices for the first time. More surprisingly, participants perceived the effect the use of the amplified SV utterances could have on their lives, suggesting a range of 'plans' for using their utterances. Themes were reviewed at the point when meanings were becoming apparent. The identified themes were reviewed, with the association between codes reconsidered and the underlying data examined to ensure that the data supported the allocated code and therefore inclusion in the subsequent theme. This was done as a 'cut and paste' exercise so that material could be moved flexibly as the process continued. Emphasis was on confirming that themes represented all available data, with the need to make some adjustments reflecting individual contributions as well as the aggregate results.

The accuracy and authenticity of the reported data was ensured by reference to the recorded material from which participant comments could be quoted verbatim. It was essential to ensure that interpretation of data was not influenced by researcher bias or open only to researcher interpretation. However, amplified utterances could be heard, demonstrating the meaningful nature of the words, irrespective of the researcher's elucidation and interpretation, enabling parents, teachers, care staff and three moderators to also listen to recordings, examine and discuss meanings in order to confirm the transcription and supporting the interpretation of the content. Participants too were invited to comment on the researcher's understandings although most were

more concerned with using their recording time for other purposes, rather than re-visiting and considering previous comments, a preference that the researcher had to respect.

During the process of reviewing themes, annotated notes enabled the researcher to maintain a degree of coherence in tracking and considering the interpretation of themes and sub themes. See sample Appendix XXIV. By returning to the relevant participants' data, it was possible to check that data supported themes, sub themes were appropriate and that they were distinct and different. Although some sub themes appeared similar (e.g. voice and quality) the researcher interpreted these codes as very different, signifying something particular to the participants. While 'voice' was about participants' recognising that they had a newly discovered audible voice, 'quality' expressed a concern about how they produced their utterances- how others heard them and whether they sounded odd or funny. Although the discovery of the 'voice' was to be celebrated, any perceived oddity in the sound was not.

Due to the nature of the experience for individual participants, recordings often recounted personal experiences, for example happenings specific to family life but resulting in divergent subject matter for different individuals. However, analysis of data focused selection on data that explored, described and illustrated participant perceptions of SV utterances in relation to the research studies. Recordings relating personal matters were addressed but were not appropriate in the context of analysing participant perceptions.

8.7. Phase 5: Defining and naming themes

Phase 5 encompasses the definitive essence of the themes, refining how they relate each to another, to ensure that the data is accurately interpreted and reported. An analysis of each theme was undertaken to identify the breath and scope of the theme, encapsulated by an ascribed name. Participants were again invited to ensure that the researcher's identification of themes was appropriate and representative of their perceptions. Although most were able to ensure that their comments had been correctly transcribed, that is the researcher had written down what they said, contributing to interpretation of those comments proved to be more problematic for some, perhaps being a more reflective task than they wished to undertake.

The main overarching themes that emerged were:

Audible Speaking - This theme encompassed responses to the very new experience of hearing their own SV utterances and elicited the greatest number of responses in a variety of references e.g. voice, quality, words, speaking.

Theme 2 Emotions and feelings – how participants felt about their SV utterances and their expressions of their concerns and worries now that they could express them.

Theme 3 encompassed 'Plans' - essentially what participants thought they could now do using their utterances

Theme 4 About me - This expressed the participants' recognition of their ability to share worries, concerns, emotions, some not reported here for reasons of confidentiality and sensitivity.

Theme 5 Developing and using language (as SV utterances)

See Appendix XXV Samples of main themes

8.7.1. Phase 6 : Writing up

Braun and Clarke (2019) present this as the final step, where the researcher weaves together the narrative and the analysis to present the interpretation of the data.

This is presented below, with participant examples.

8.7.2. Response data

Data arising from the exchanges were collated as responses from all participants but the number and extent of replies varied across the research group. In order to clarify frequency the following terms were used:

Most participants - between 75%- 100% participants.
Many participants – between 50% – 75% of participants
Some participants – between 25% - 50%

SECTION 2

8.8. Analysis of themes and sub themes

This section presents and analyses the themes and sub themes identified in participant data. Themes showed a degree of sequential cohesion as exchanges with participants largely followed the same order, often tracking the experiences of the participants in using SV utterances as the research progressed. In this manner, participant responses often replicated that of the other participants, thereby facilitating a similarity of content yet sufficiently varied to ensure that contributions were individually derived.

The main themes to emerge were related to Speaking, Emotions and feelings, Plans, About me, Developing language. Samples from recorded data are presented to demonstrate participant contributions and the emergent themes. Samples are attributed to individuals as research participants by their identifying number. (Participant details are presented in Chapter 3, Methodology, Table 4.)

Kondraki and Wellman (2002) advise that preconceived categories should be avoided so that names for themes should evolve from the data. This was the case with the first key theme, arising naturally in relation to the experience of ‘speaking’ and emerging in response to the researcher’s invitation to talk about their production of SV utterances. The novelty of the experience of hearing their own audible utterances for the first time was common to all participants contributing utterances to the research. Generic responses emerged in relation to how individuals perceived the experience, presenting data that could be collated into a theme of ‘Speaking’ with a range of associated subthemes

Responses were almost exclusively concerned with aspects of audible phonation with a number of related sub themes emerging including ‘talking,’ ‘hearing/heard, ‘voice, ‘sound,’ ‘words,’ ‘listen.’ Most participants commented on hearing their own voice audibly (via play back of their first recording) with some contributing a range of comments attributing issues with ‘the mouth’ as significant in speaking, either as a problem inhibiting speech or as function that was now ‘working’ to enable utterances to be produced. Additional comments regarding the ‘voice ‘ contributed more to the theme of ‘speaking,’ as did participant remarks concerned with ‘hearing’ or being ‘heard’ in relation to their SV utterances. As demonstrated below, participant’s

perceptions formed meaningful clusters where coded responses were linked and related.

8.8.1. Theme 1: Audible Speaking

Initially, the theme of 'speaking' emerged, in response to the researcher's explanation that participant words could be recorded and replayed audibly. Although participants never queried the researcher's assertion that they could use language, issues arose regarding the potentially audible nature of their utterances. Participants demonstrated that they held contradictory views.

During the first recording sessions, in answer to the researcher's explanation that 'your soft voice inside you' would be recorded and played back, some participants expressed views related to the validity of the information they were given

Chapter 8 a sample

Participant 14 : That's not true!

Participant 3 : I speak…..lot of rubbish.

Participant 2 : This is rubbish, this is shit.

Participant 16 : I never speak

The difficulty expressed by participants in accepting the explanation given by the researcher is apparent. Although it is not possible to determine the period of time within which internal language and SV phonation had operated for individuals, it is apparent that it would have been concealed from those around them and indeed, in an audible form, from the participants themselves. The normally inaudible nature of utterances and the difficulty for participants in demonstrating language acquisition mitigated against the possibility of others acknowledging their linguistic ability. Participants could

not have experienced the responses of others to their SV language, and the possibility of this occurring audibly appeared to be outside their frame of reference. Although participants were aware of their use of their own inaudible language, as made clear in later exchanges, they did not anticipate that their inaudible utterances could be made audible via the computer.

Following audible playback of their recorded utterances, some participants also expressed doubts about their ability to produce audible samples, despite hearing evidence of their ability to do so. Some appeared to be aware of the limitations imposed by their physical impairments. Others offered different explanations for their perceived inability to 'speak,' suggesting that participants were aware of their internal and inaudible language but also aware of their failure to demonstrate this to others. Their capacity to think about and respond to the information given to them identifies the meaningful nature of their language.

Chapter 8 b sample

Participant 9: Can't, with this mouth

Participant 1: We've heard, 'he'll never speak.'

Participant 5: There's a problem

The participants expressed their understanding of why they cannot speak aloud, ,responding meaningfully to the researcher. Participant 1 refers to past experience, demonstrating his ability to move between the present and the past.

Two participants attributed the verbal playback of their SV utterances to the agency of

the equipment used with them, recognizing the association between the equipment and the audible playback of their utterances. They made meaningful associations between what happened with their voice and the equipment that recorded and amplified their SV utterances. Participant 20 describes his experience, using abstract concepts of 'weird', 'love', and 'dream.'

Chapter 8 c sample

Researcher: Do you want to take them off?

Participant 5: 'I can't talk without them.'

Researcher: Want to take the headphones off?

Participant 20: They are good
It sounds weird
I'm talking with it now
Chat with her

Researcher: Might still be recording

Participant 20 I love that
My dream, they will give me this

In contrast, some participants reflected upon previous problems related to their 'mouth' implying that these had now been overcome. They appear to have thought about their failure to speak aloud and reached a conclusion when hearing their amplified utterances.

Chapter 8 d sample

Participant 12: Rose..my mouth works

Participant 15: Can she work .....the mouth?

For those participants where comments related to the role of the mouth, it is possible that their previous experience in attempting speech were confounded, despite their intent and understanding of the words that they attempted to produce. For some individuals, vocal output was normally extremely disordered so that attempted verbalisation could not have been recognised as meaningful, even if intended to be so. The mouth did not work. In contrast, SV utterances where the complex integration and operation of the speech structures with respiratory effort was perhaps less significant, less complex indeed, production of coherent SV utterances was not so problematic. Disordered phonation was not as apparent in amplified SV samples as in audible vocalisations.

The response of one participant suggested an alternative understanding of his failure to communicate his utterances to others. After hearing his SV recordings replayed, Participant 8 implied that previous vocalisations had been alien to those around him. He reported his understanding of his audible utterances.

Chapter 8 e sample

Participant 8: I can speak English

8.8.2. Sub theme: Quality of utterances

Some participants clearly recognised the major difference between their SV language as audible recorded versions and normal speech. Despite hearing audible playback of their recorded utterances, they expressed concerns about the quality of their audible phonation.

Chapter 8 f sample

Participant 2: Please say that's not funny.

Participant 13: What's that? , Would I talk ?

Participant 20: I think the voice is ..getting funny

The queries about the quality of their utterances suggest that participants were

uncertain about their ability to be understood. As noted above, the inaudible nature of their SV utterances in conjunction with the disordered nature of their audible phonation mitigated against other people hearing their comments. When first hearing amplified SV utterances, participants may have assumed that their normally disordered voice was now speaking aloud, a form of phonation generally misunderstood but now made clearer. Due to previous experience, the concern that these sounds would not be 'decent' was understandable.

The concerns expressed by participants regarding the quality of their utterances reflect the outcomes of Study 2, where intelligibility of single and contiguous words was tested. SV phonation is atypical. Results in Study 2 showed that utterances could be correctly perceived but some samples scored higher for intelligibility than did others. There were variable outcomes reflecting variable degrees of clarity and intelligibility for listeners. Although recorded utterances demonstrate variations in phonation and articulation in and between participants, the clarity of BBC English occurs infrequently. More usually, utterances lack the articulatory precision common to normal speech. As described in Study 1, participant phonation could miss articulatory targets even though words could still be perceived by the listener. Thus, even when hearing playback of their SV phonation, doubts about the quality of the sample was natural. Although only those samples that could be perceived (by the researcher or class staff generally) were played back, the difference between the SV utterances and normal speech would often be apparent.

Although some participants expressed doubts about the quality of their utterances, most responded positively acknowledging and celebrating what they heard.

Responses appeared to indicate both surprise and pleasure on the part of individuals with some still uncertain about the authenticity of what they heard.

Chapter 8 g sample

Participant 4:	I said those words, I think
Participant 15	Is that me, everybody heard
Participant 17:	I love that sound

8.8.3. Sub theme: Voice

Despite the sub vocal nature of their utterances, participants appeared to understand the concept of a ‘voice.’ It is not clear if recognition of their recorded voice occurred because the researcher told them it would be their voice, or if they had some awareness of how their own spoken voice would sound, despite not having heard their own audible SV voice previously. Their remarks further reinforced the probability that linguistic utterances had always been sub vocal and therefore never acknowledged by others or indeed heard aloud by the participants themselves. The recognition that they could now use a ‘voice’ was a common topic upon which most commented.

Chapter 8 h sample

Participant 6: This is my voice

Participant 8 Here it is..the voice

Participant 2: My voice, speaking with sound

The description by Participant 2 of 'My voice, speaking with sound' is perhaps most illustrative of the experience for participants of hearing their amplified sub vocal phonation. Although aware of their own inaudible utterances, the recorded playback enabled them to hear their own audible voice, expressed verbally due to the amplification provided by the software. This had implications for the generally accepted view of them as 'pre-verbal,' as they were unable to verbalise (until amplified) as noted above but their failure to produce verbal utterances may have occurred as a consequence of their physical inability to manifest their speech audibly. They were pre-verbal in that sense, with their failure to speak aloud as a result of their impairments and not as a result of linguistic or development delay. Their previously inaudible SV utterances could now be heard as verbal speech, albeit via the computer.

8.9. Theme 2 : Speaking and talking

In response to the researcher asking participants 'What do you think about hearing your words out loud, many participants commented on their 'speaking' and 'talking', apparently aware that their SV utterances, once amplified and made audible were functioning as real speech. They understood and commented on the experience.

Chapter 8 i sample

Participant 3: I was speaking. I am looking good, very nice

Participant 14: Did speak (laughs) Yeah

Participant 12: Listen I'm speaking. Brilliant

Participants not only acknowledged the use of their voice to 'speak,' but were clearly aware that the utterances were made up of words. They recognised that their utterances were language and commented on that fact.

Chapter 8 j sample

Participant 20: They say that they heard language

Participant 11: Rose has heard my words

Participant 13: Now, my words

In reflecting on their ability to produce audible words participants demonstrated their previously unrecognised language acquisition. By using their SV words to comment, they were able to show the extent of their linguistic competence, reflecting outcomes in Study 3 where developmental and linguistic levels above infancy were assessed by the content of utterances.

8.9.1. Theme 2: Emotions and feelings

Participants expressed their feelings about their SV speech. In response to questions about hearing their amplified utterances, a theme arose from data from all participants expressing their feelings regarding their SV utterances. They used a variety of terms, demonstrating that that their emotions were not reflective responses as might be expected in an infant, but feelings that they could express and understand. The use of abstract concepts relative to emotions and feelings offer demonstration of the meaningful nature of their language.

Chapter 8 k sample

P.16 I've been desperate

P8 It's very lonely

P17 I love that sound

Participant 7: Let me sound happy

Participants also made clear that 'speaking' was something that they had wanted for themselves. It gave them pleasure to hear their utterances

Chapter 8 L sample

Participant 2: My dream, talking with Dad

Participant 15 Talk mother. It's something that I can.

Participant 14: My voice is alright.

Participant 9: Talk to mum, and I love to.

8.10. Theme 3: making plans

A second key theme emerged in relation to the affects that the use of SV phonation could have on participant lives. Sub themes included making others aware of their abilities and how and what participants wanted to do about their utterances. They demonstrated a capacity to plan and make decisions about the use of their newly demonstrated abilities. Planning and making decisions were indicative of the capacity of participants to advocate on their own behalf, expressing their intentions.

8.10.1. Sub theme: Telling others

Participant responses during the earliest recordings included the request by most participants to share the news with others. Initially, many participants recognised that their ability to produce audible utterances had implications for their family, with participants wanting to share their news with their parents. This was an area where participants led, and the researcher followed up comments and ideas expressed by them.

Chapter 8 m sample

Participant.13 Mother, come and listen

Participant 5: Please get my Dad

Participant 10: Get mummy

Mum it's me

Some participants inferred that they had battled against adversity in the past, aware of their linguistic competence but previously unable to let others know about their abilities. Hearing their own audible utterances appeared to represent something of a 'triumph.'

Chapter 8 n sample

Participant 1: Now we've won, they will record me.

Participant 18: We have done it!

8.10.2. Theme 3: Plan3

Theme 3 reflected how participant perceived the effects of using SV utterances on their lives. By their responses, most participants made clear the value of the SV utterances to them. Some articulated a specific plan for using their utterances, via the computer equipment, while others requested help to improve their SV utterances. In all cases, they demonstrated their ability to be agents of their own lives, clearly knowing what they wanted to do with their SV utterances and advocating on their own behalf. The reference to their 'plans' implied an ability to understand their own problems and recognise that their utterances were a potential solution.

Participant 13 explained his plans for using his SV utterances, by working with the researcher, culminating with:

Chapter 8 o sample

Participant 13: You are a person for help

My plan was you

I know.

Participant 20 planned to have the computer for himself.

Chapter 8 p sample

Participant 20:My plan, my dream, they will give me this

Some participants requested further teaching and learning, perhaps in the expectation that they could increase the use of their utterances with the computer. Having once heard that their language could be amplified sufficiently to be audible, they asked for help in doing so.

Chapter 8 q sample

Participant 11. She can teach this

Participant 15: Something that I can …….learn

Participant 1 Tell the teachers..to help

Participant 7 Someone help me

Participant 2: I need help

The requests for help and the suggestions for meeting their needs that were presented

to the researcher was a further indication of their confidence in their ability to ‘manage’ their own lives and make decisions on their own behalf. Even though all the individuals in this research were completely dependent on others for all their needs, they expressed their wishes, confounding the generally held belief that they could not advocate on their own behalf. They knew what they wanted and were able to express it. In advocating on their own behalf, participants clearly demonstrated the meaningful nature of their utterances with responses which were significant, important, relevant, valid and purposeful. They were contextually appropriate, using the opportunity to advocate for themselves. They were abstract, reflecting ideas that do not physically exist and culminating in future abstract plans.

Most participants demonstrated their awareness of the significance of the computer technology as the means for them to use their SV utterances, apparently recognising what could be done with it. They wanted to have access to it, expressing both their desire to use it and their understanding of the technology as a means to enable them to interact with others.

Chapter 8 r sample

Participant 14: That (the computer)…would work

They might listen

Participant 18 Could I learn to rely on that?

I might talk back.

With the computer, I could try.

Participant 20: I use this to speak

8.10.3. Sub theme: Communicating with utterances

When asked how they would like to use their SV utterances, most participants wanted to communicate with others to express concerns, worries or news, previously obscured by their inability to use their utterances audibly. These responses covered a range of issues, but made clear that participants had topics that they wanted to share and that previously remained unsaid. They recognised that SV utterances gave them the opportunity to do so. They used their SV utterances as a communication strategy that would enable them to convey messages or tell others about their concerns or news, their needs and wants. They could also ask for information that they wanted, a basic need previously unavailable to them.

Chapter 8 s sample

Participant 13: I must tell ‘er

Please get mum

Researcher: Would you like to say something for mum because we could have a message on the computer for mum.

Participant 8: Tell her to love me. We should say that.

Researcher: What sort of present were you thinking?

Participant 1: Flowers for her birthday

Participant 1: Rosie, there’s a letter.

8.11. Theme 4: About me

8.11.1 Sub theme: My health

An emergent theme concerned the health of participants. They made clear their intention to use their SV utterances to address their health needs. All individuals had complex health needs that impinged constantly on their everyday lives and for some, worries about their health were central to their everyday experience. Unfortunately, many were aware of the loss of peers, perhaps reinforcing their own concerns.

Participant 3 recognised how her SV communication had the potential for overcoming some of her health concerns. After telling the researcher about them, issues that she

had raised were addressed. She expressed what that meant for her.

Chapter 8 t sample

Participant 3: I know what's planned. I feel safe.

The ability to use utterances appeared to provide a 'safety net' for those with very complex medical needs, often querying or reporting issues related to their particular conditions, in some cases life limiting. Although these comments are not reproduced here for reasons of confidentiality and sensitivity, it was apparent that medical information was often discussed in front of participants by medical personal (authenticated by parents who were obviously present on the same occasions) presumably unaware that the individuals they were discussing understood what was being said. Comments made by participants made clear that they were often distressed and worried about their health and, before recording their responses, they had lacked any means to address their concerns. Parents of Participant 12 reported that, at every hospital appointment, when life support for their son was discussed in front of him, the possibility that would worry him was not considered. Access to the use of their utterances offered the chance for individuals to express and explore their worries regarding health issues and some did so on a number of occasions.

8.11.2. Sub theme: My worries

Although concerns regarding health issues clearly addressed matters of real importance, participants also talked about less significant matters, but of personal

importance to them. Participant 1 was asked about potential transfer to a residential college, a decision made for him by others but without his contribution to the decision

.

Chapter 8 u sample

Researcher: How do you feel about going to college?

Participant 1:I'm frightened.

Participant 14 was invited to contribute his opinion

Researcher: Would you like to go to college, Day Centre of Special Unit?

Participant 14: College

She can be near us.

Despite the encouraging commentary offered by carers and family of Participant 1, stressing the excitement and enthusiasm that they proposed to be associated with the move, his 'frightened' response to the question about college emphasised the need to explore how the participants felt about events in their own lives and the difficulties in enabling them to share such feelings with others. In contrast, Participant 14, offered a choice of (non-residential options) could contribute his own decision, clearly showing choice making abilities, contrary to some research that queries the ability of people designated PMLD to do so (Cea and Fisher, 2003., Felce, 2002., Ware, 2004).

Others wanted to use their utterances to convey news or tell others what they wanted to do. It also provided an opportunity for participants to ask for or express preferences.

They were asked what they liked to do in school.

Chapter 8 v sample

Researcher: What do you like to do at school?

Participant 13: Back in school, the swimming pool.

Participant 3: I like Boccia (a game) very much

Participant 9: Talk, that is what I wish

8.11.3. Sub theme: My self esteem

A prevalent sub theme encompassed how individuals perceived themselves, apparently in contrast to how others viewed them. Despite the commonly accepted view that people designated PMLD were intellectually limited, participants did not appear to share this view. Some had clearly heard adults attributing deficits to them. In contrast, participants presented their use of SV utterances as indicative of their abilities. They saw themselves as competent, in contrast to the commonly accepted view of their limitations offered by those around them. They obviously did not perceive themselves as infants.

Chapter 8 w sample

Participant 7: I'm not stupid. This is speaking.

Participant 11: You can hear me because I'm clever

Participant 12: I'm….brilliant Rose

Participant 15 My friends say nothing..I talk

Other comments by participants reflected their self-regard and self-esteem. It was not unusual for participants to include swear words in utterances, perhaps wishing to appear more mature or adult, especially in the teenage years. However, they observed the niceties of social etiquette, apologising in some cases or recording without swearing if asked not to swear. Although respectful towards the researcher, they were not deferential, instead asserting their own views and contradicting her on occasions. Participant 18, having answered general knowledge questions, reminded the researcher of what she wanted to do. Similarly, when interrupted by the researcher at the beginning of his recording, Participant 2 politely reminded the researcher not to interrupt.

Chapter 8 x sample

Participant 18: I come here Rosie to record.

Participant 2: I've started please

8.12. Theme 5 : Developing language

A theme emerged in response to participant comments around the development of their language. Using questions loosely based around ‘When did you start speaking?’ the researcher explored with participants the development of their utterances. However, no individual was able to explain how or when they had learnt to produce them. As with the population generally, language appeared to have developed without any specific memories of the gradual acquisition of words.

Despite their failure to remember when and how their language had developed, it was apparent that it was firmly established and not a recent or new response to the researcher. The researcher hoped to gain some insight into the experiences that had facilitated their language development but participants were unable to offer any explanations. In addition, educational records for participants made clear that input from speech therapists, working in conjunction with teachers to develop communication strategies, did not envisage either speech or language at levels demonstrated by participants. Understandably, for staff working with pupils, where there was no evidence that linguistic abilities existed there was no reason to assume otherwise and language was not ‘taught.’ Consequently, communication interventions were designed to be pre-linguistic, reflecting the assessments derived from Performance Levels at P4 and below, attributed to the participants as PMLD individuals.

Although there was no evidence of structured language input offered to participants during their education (even for the young adults who had attended education for

many years) participants were asked to explain what they remembered about acquiring their language.

Chapter 8 y sample

Participant 2: In my head, I talk

Researcher: Can you remember when you first started speaking?

Participant 11: It is far back.

Researcher: So have you always been talking very softly?

Participant 11: Yes

Researcher: Is it difficult for you to speak out loud?

Participant 11: It's a pain

We don't feel bad,
That doesn't help us

Researcher: Can you tell me how long you have been speaking for?

Participant14: It has been in the head
I have had it all this time, its fine.

Researcher: Is it a struggle to use your voice?

Participant 1 Yes
We need the computer
Can't talk……. terrible nerves

8.12.1 Sub theme: Inhibited language

Despite the pleasure that participants took in hearing their inaudible utterances made audible, it became apparent that some participants were worried or nervous about revealing that they could ‘speak.’ Some explained that previous experiences in trying to use their voices had been negative for them. Participant 14, explained that his ‘talking’ was not encouraged.

Chapter 8 z sample

Participant 14: They weren’t the ones that let me. They stopped us.

It would undoubtedly be of interest to undertake content mining (Legard et al 2003) to examine further the underlying concerns implied in the above samples. Previously an individual designated PMLD had informed the researcher that adults told him ‘not to make those noises’ when he tried to communicate with his voice, inevitably producing loud, dysarthric type utterances that appeared meaningless to those around him. If audible vocalisations were efforts to produce audible, meaningful utterances, they were discouraged, apparently regarded as drawing inappropriate attention to the individual. Understandably, in a range of social settings, loud distorted vocalisations were disruptive and therefore discouraged, perhaps unintentionally inhibiting efforts to communicate using the voice. As Participant 14 reports above, ‘They stopped us.’

8.13. Summary

Audible samples of responses obtained in semi structured interviews demonstrate the intelligibility of participant SV, supporting the outcomes of Phase 2 where tests of listener intelligibility also established the intelligibility of SV utterances.
The content and structure of interview responses also supported the outcomes of Phase 3 where the linguistic and developmental levels of participants were assessed as beyond 24 months.

The outcomes of Phase 4 demonstrated that participant comments in semi structured interviews met the criteria for 'meaningful' as defined by the Oxford English Dictionary and their responses to questions were contextually appropriate. In addition, they also contributed meaningful spontaneous utterances of their own devising and construction. Further, the use of abstract concepts was demonstrated, with participants showing their capacity to express emotions, make plans, convey their concerns, refer to past, future and present and give their views and opinions.

Interview responses also demonstrated that participants did not operate linguistically or developmental at levels with 0-24 months. Recorded SV responses demonstrated that participants understood the limitations of their own situation, recognizing that, prior to the research recordings, their internal language remained hidden and unrecognized. Some had difficulty in acknowledging that the amplified recordings were their own comments and their use of audible language was a revelation. All participants knew that (previously) others in their lives were not aware of their language and that it did not function verbally. As a consequence of their participation in the research, they understood that they could 'speak' and used their ability to do so without question when recorded by the researcher. No single participant attributed to themselves the

profound intellectual and linguistic delay attributed to them by others. All comments reflected linguistic and cognitive levels above levels associated with infancy, offering supporting evidence for Study 3 where utterances were aligned with assessment criteria to demonstrate developmental stages beyond 0-24 months. As reported in Study 3, comments revealed grammatical forms and prosody aligned with characteristics in normal language up to 5 years

In acknowledging their use of SV language, there were no indications by participants that they perceived themselves as infants. Their responses identifying their own use of language correlated with results of Study 3 where utterances were assessed to be beyond the stages of infancy and followed the rules and conventions of normal language. Many recognised that the ability to use language was indicative of competence not commonly attributed to them, asserting that they were not stupid or lacking sense. Their ability to do so in spite of the daily incidents that failed to recognise their understanding and use of language, and an education predicated on the assumption of profound developmental delay, supports the possibility that they did not recognised in themselves the intellectual limitations ascribed to them. Many exuded confidence in themselves, using words to acknowledge themselves as having ‘sense’ or being ‘brilliant,’ or ‘clever.’

Participants were clearly aware that their utterances existed, initially operating inaudibly until amplified. Most expressed their delight in being able to demonstrate their language. Some expressed their concerns regarding the quality of their audible SV phonation, perhaps anticipating the disordered outcomes that their audible vocalisations produced. Participants’ concern about the quality of their amplified SV phonation reflected the reality of the results of Study 1, where mis-articulations were

identified and the results of Study 2 where listener intelligibility varied, particularly for contiguous utterances. Thus, participants recognised the intelligibility of their SV utterances in contrast to their disordered audible vocalisations, acknowledging that they were ‘speaking,’ or ‘talking,’ when hearing their recordings. Their positive responses in recognising that they could ‘speak’ and be heard expressed the value of the experience for them. They clearly recognised too that the content of utterances were meaningful and never queried that fact with the researcher.

In responding to the researcher appropriately, and engaging in a dialogue or conversation with her, participants were clearly aware of her as listener and partner in an interaction, and of their role in contributing to the conversation. They demonstrated that they were capable of focussing on a subject of joint interest, using turn taking appropriately and observing the conventions of normal social etiquette as reported in Study 3.

Participant comments illustrated their ability to use their knowledge and experience to make plans. Most participants wanted to use the utterances to communicate with others, particularly parents, requesting that the researcher inform parents of their child’s abilities. Most participants requested help with their utterances, offering a variety of ways to use or improve their SV phonation and clearly demonstrating their ability to advocate for themselves. Many wanted to ‘learn’ more or acquire the equipment that produced their audible voice. In this, they again demonstrated their capacity to plan for their own future, advocating on their own behalf using abstract meaningful concepts.. Another subject common to many concerned health issues, including bereavement issues. This had not been considered as a subject relevant to

people designated PMLD despite the complex and severe nature of their impairments, yet utterances revealed a degree of anxiety and distress that indicated concerns about their health and life expectancy. Their requests for further information in these areas exemplified their understanding of their present and future lives, showing the attainment of meaningful, abstract concepts. .

Data from the interviews identified the impact on participants on knowing that their SV utterances could be heard as meaningful. Responses also identified that they had not heard their utterances previously, although many made clear that internal language had been present, ‘in my head’ (Participant 14) for as long as they could remember. This was not a new phenomenon to them. However, participants were clearly aware that those around them had not heard or recognised their ability to use language.

The combination of quantitative data to support qualitative data facilitated a wider and more comprehensive understanding of the data overall, reflecting and integrating participant accounts into the study. Participants added their own descriptive and analytical accounts of their sub vocal utterances from the perspective of those most experienced in, and knowledgeable about them. Their ability to express themselves as shown in Phase 4 provided meaningful insight into the human aspect of this research. Their abstract perspective of their experience could not have been so clearly obtained by any other means.

Finally, the type and nature of participant responses were themselves indicative of their linguistic and developmental stages, providing evidence that they are not pre-linguistic or profoundly developmentally delayed. Their utterances were meaningful.

They operated as perceptive beings, using their SV language to demonstrate the linguistic, intellectual, social and emotional characteristics that typify sentient beings. The use and nature of their SV language clearly demonstrated that they were not simply responding to sensory stimuli in the manner of developing infants.

Following the findings of the four phases of the study issues arising from the research are addressed in Chapter 9: Discussion and Conclusions.

CHAPTER 9: Discussion and Conclusions

9.1. Introduction

This chapter : is divided into two sections.

Section 1:

- Presents and summarises the key findings
- Presents the original contribution to knowledge

- Combines and integrates the outcomes of the four phases of the study
- Details the strategy for disseminating the results

Section 2

- Contextualises the findings within previous and current literature and theory
- Considers the implications of the research findings including the implications for practice and future research.
- Examines the strengths and limitations of the research
- Reflects upon the impact of the research on the participants.

Section 1

The purpose of this research was to investigate the use of SV utterances by 20 children and young adults designated PMLD as a means to test the hypothesis that:

Children and young adults designated PMLD can produce meaningful sub vocal utterances intelligible to listeners.

To investigate this proposal, the research was comprised of four interlinked phases constructed to answer four research questions:

How do SV utterances compare acoustically and phonetically with normative samples where instrumental analysis allows comparison of the acoustic phonetic features?

Are the SV utterances intelligible such that familiar and naïve listeners would be able to understand the amplified samples?

How sophisticated is the language used in utterances? Does it demonstrate linguistic and cognitive levels beyond the developmental age of 24 months attributed to individuals designated PMLD?

Are the SV utterances produced by the research participants meaningful?

In this account of the phenomenon of SV utterances by the research participants, it is important to note that the research is exploratory and descriptive and seeks to indicate the most appropriate areas for continuing in-depth study. Further robust research is required

9.2. Key findings

Following investigation of the four research questions in the four phases of the research, the following key findings resulted:

Key finding 1

SV utterances produced by the research participants can be analysed and compared with normal speech and whisper using Praat as an instrumental tool.

In Phase 1 where acoustic phonetic features in participant SV utterances were compared and analysed in relation to normal speech and whisper, results identified features integral to SV utterances, normal speech and normal whisper. The presence of vowels in SV utterances, in relation to the appropriate articulatory position confirmed the presence of a 'speech like' event in SV utterances.

Key Finding 2

Results from Phase 2 where intelligibility of SV utterances was tested identified that:

SV utterances were intelligible to 40 listeners (20 naïve and 20 familiar) in 7 closed tests and 3 open tests in a range of conditions.

Key finding 3

The content and structure of participant SV utterances are developmentally and linguistically beyond those associated with infancy.

Results from Phase 3 identified that :

The content and structure of participant SV utterances evidenced developmental and linguistic levels beyond the developmental stages associated with infancy (0-24 months) attributed to people designated PMLD.

Key Finding 4

The research participants designated PMLD can produced meaningful SV utterances that are:

- ‘significant, important, relevant, valid, purposeful.
- contextually appropriate
- using abstract concepts including views, opinions and ideas

As a result of the investigations undertaken in the four phases of the research, results converged as Key Finding 5 to confirm the hypothesis:

Key Finding 5

Children and young adults designated PMLD can produce meaningful SV utterances intelligible to listeners

9.4. Original contribution to knowledge.

- The identified presence of intelligible, meaningful SV utterances in 20 research participants designated PMLD is an original contribution to knowledge.

The presence and use of SV utterances identified in the PMLD participants is not reported in the literature and is contrary to current expectations of the ability of people designated PMLD.

- The presence of phonetic and acoustic features of normal speech and whispers in SV utterances by the 20 research participants is an original contribution to knowledge.

The ‘speech like’ features identified in participant SV utterances have not been identified previously or reported in the corpus, possibly as a consequence of the

inaudible nature of participant SV utterances

- The use of Praat as an instrumental means of analysing SV utterances by participants designated pre-linguistic is an original contribution to knowledge.

Sound software to analyse speech and whispers is commonly used for normal and disabled phonation but has not been applied previously to SV utterances by people designated PMLD. The reported capacity of Praat to do so is an original contribution to knowledge.

- The recording and amplification of participant SV utterances is an original contribution to knowledge, demonstrating that PMLD utterances can be recorded and amplified to become audible and intelligible.

The existence of SV utterances by the research participants has not been recognised, prior to this research and the recording and amplification is a completely novel approach to accessing the SV utterances.

- The demonstrated capacity of 20 participants designated pre-linguistic to acquire and use SV language including symbolic and abstract forms is an original contribution to knowledge.

The inaudible nature of SV utterances in combination with the understanding that PMLD individuals are pre-linguistic has mitigated against expectations that the research participants could or would acquire this form of language.

- The ability of the participants to produce SV utterances intelligible to listeners is an original contribution to knowledge.

Results of the listener tests contributed unique information about the ability of the research participants to produce SV utterances and the ability of listeners to perceive and understand them. Despite the atypical articulation of some participants and the poor acoustic quality of some samples of the SV utterances, results of listener tests identified that utterances were intelligible.

- The identification of the linguistic and developmental levels of research participants exceeding those currently attributed to them (0-24 months) is an original contribution to knowledge.

Currently, individuals designated PMLD are understood to be profoundly developmentally delayed, operating at levels associated with infancy. Evidence of the higher levels beyond infancy are not anticipated as participants are unable to demonstrate competence in assessments due to the severity of their physical and sensory impairments. Thus, their failure to respond to assessment measures that require observable outcomes have maintained the assumption of their profound linguistic and developmental levels. .

- The ability of the research participants to spontaneously learn, retain and demonstrate knowledge (political figures and events for example) not directly taught to them is an original contribution to knowledge

Contrary to the current understanding of the limited learning style and capacity of

PMLD individuals, the research participants demonstrated their ability to acquire for themselves knowledge and information incidentally, without teaching to facilitate or structure their learning.

- The ability of the participants to use linguistic conventions in language is an original contribution to knowledge.

In addition to acquiring the ability to use SV language, participants have also acquired grammar, vocabulary, intonation and turn taking that enable their language to function in ways that parallel the operation of normal language.

- The use of SV utterances as a communication intervention is an original contribution to knowledge.

Throughout the research, access to recording and transcription of participant SV utterances was recognised and used by the participants and the researcher as a means of communication. Although the focus of the study was not on the communicative function of SV utterances, it became clear that participant SV utterances operated as such.

- The use of the content of SV utterances as an assessment measure for the 20 research participants is an original contribution to knowledge.

The use of the content and structure of SV utterances, as a precise and concise means to establish previously unrecognised linguistic and developmental levels of the

PMLD research participants has not been reported previously. The use of three assessment measures demonstrated competencies despite the range of physical, sensory and motor impairments that inhibit access to current assessment strategies, where observable responses unavailable to the participants are required.

- The ability of participants to formulate and express views, opinions and ideas and to self advocate is an original contribution to knowledge.

Research studies propose that people designated PMLD cannot contribute to decisions or self advocate on their own behalf due to their pre-linguistic and pre-intentional status and their inability to formulate views, opinions and ideas. SV utterances demonstrated the ability of the participants to do so.

9.3. Combined results.

This research addressed different elements of the phenomenon of SV utterances by the research participants, each requiring a different focus and different methods. Consequently, a mixed methods research design was implemented to ensure that disparate aspects of the study could be investigated appropriately, employing quantitative and qualitative methods in 4 corresponding phases. This approach facilitated detailed examination of properties integral to SV utterances, allowing closer and more specific aspects to be examined, each producing outcomes contributing to the aggregate picture.

This discussion now integrates the different data sources from the different phases. The rationale for doing so is to broaden the interpretation of the results of each phase,

integrating data where appropriate and recognising that the availability of different types of data functions to conceptualise findings, enriching the results with different types of information. The mixed methods employed for this research has facilitated data triangulation, by using and combining multiple sources of data to support the credibility and validity of the findings, ensuring too that bias arising from the efforts of the single researcher or a single method can be surmounted. As Heale and Forbes (2013) contend:

- Results may converge, leading to the same conclusion, enhancing the validity of the outcomes
- Results from different features of the phenomenon may be mutually complementary, supplementing and strengthening the individual results or underscoring different features.
- Results may diverge or be contradictory (potentially identifying that one or more data sets are flawed) encouraging further investigation to produce new or more valid outcomes (Tashakkkori and Teddle, 2005)

As reported above and as advised by Tashakkkori and Teddle (2005), results of the four phases are mutually complementary, converging, supplementing and strengthening the individual outcomes. There are no contradictory findings but additional investigation in Phase 1 to develop and extend findings is to be encouraged.

In Phase 1 the acoustic phonetic features identified in participant SV utterances, including the evidence of the presence of vowels, supported the proposal explored in Phase 2 that SV utterances are intelligible.

In Phase 2, where intelligibility was explored, SV utterances contained sufficient acoustic phonetic features to be correctly perceived as intelligible by listeners. The intelligibility demonstrated in Phase 2 supports the proposal in Phase 1 that the utterances do contain 'speech like' acoustic phonetic features, including vowels, the nucleus of nearly every syllable.

The ability of listeners in Phase 2 to correctly perceive SV utterances in open and closed conditions as single and contiguous words supports the proposal that utterances are intelligible.

The ability of listeners in Phase 2 to correctly transcribe single and contiguous utterances supports the proposal in Phase 4 that utterances are meaningful.

In Phase 3 assessment of the content of SV utterances demonstrate the developmental and linguistic nature of SV utterances, also supporting the proposal in Phase 4 that participant SV utterances are meaningful.

Audio samples in Phase 3 and Phase 4 provide evidence of the presence of vowels identified in Phase 1, the intelligibility assessed in Phase 2 , the linguistic and developmental structure and nature of SV utterances examined in Phase 3 and the meaningful nature of utterances proposed in Phase 4.

In using different data sources it must be acknowledged that different data sets are not necessarily comparable and may not contribute equally to findings. Consideration

must be given to the significance of outcomes to the research questions and to the hypothesis. In this research, results from Phase 1 could not be fully validated due to the difficulties in acquiring standardised samples for investigation. Results in Phase 1 where acoustic analysis identified comparable features in participant SV utterances and normal speech and whisper are insufficiently robust. Further research is necessary to substantiate findings in Phase 1. Nevertheless, Phase 1 provides data that supports the outcomes of the investigations carried out in all other phases, showing the presence of formants and vowels with the accompanying articulatory position required for the identified 'speech like' event to occur.

9.5. Disseminating the results

The need to disseminate and share the findings of the study may facilitate further research into the phenomenon of SV utterances. Consequently, a dissemination strategy was implemented to raise awareness and understanding that some individuals designated PMLD may be able to use SV utterances. In addition, where this is the case, changes in practice particularly in educational provision might follow. The dissemination strategy was implemented as follows:

Identify stakeholders

- Individuals designated PMLD
- Parents and carers
- Services and agencies meeting the needs of individuals designated PMLD.
- Producers of AAC communication devices

What to disseminate.

- The aim of the research
- The methodology
- The outcomes
- Proposed future research
- Proposed development of AAC devices (including recording of SV utterances) to produce utterances audibly and in real time.

How to disseminate

- Liaise with appropriate charities, agencies and providers
- Liaise with special schools and colleges
- Produce articles for journal publication
- Conference presentations
- Liaise with funding agencies for guidance and support

Dissemination activities to date

- Delivered staff training to implement research outcomes in Special Schools where the research was carried out.
- Presentations to 2 Further Education Colleges (meeting the needs of PMLD students)

- Presentation to families, parents/carers meeting the needs of individuals designated PMLD
- Presentation to Care Agency (Home care, children and adults with learning disabilities)
- Presentation to County Children Services
- Presentation to Toby Churchill (Company offering the production, servicing and technical support for AAC.)
- Conference presentation
- Workshop 1 and Workshop 2 April 2018, Together Conference, Hertfordshire
- On-going collaborative work with Loughborough University
- On-going meetings with parents/carers and their children at Special Schools where the research was conducted.
- On-going liaison with special schools
- On-going liaison with SEN consultancy.
- On-going liaison with Scope (charity for people with Cerebral Palsy)
- On-going liaison with Communication Matters.
- Journal article published –Communication Matters (2016)
- Journal Article in preparation (Woods, Raghavan, Brown, Cornelius and Kerr)

9.6. Section 2

9.7. Contextualising the findings within previous and current literature and theory.

This research was not designed to support or contradict theories relevant to the use of SV utterances by individuals designated PMLD, or to suggest new theoretic interpretations based on the outcomes of the study. However, the similarities and differences occurring between the outcomes of this study and current literature and current theories are explored and discussed below.

9.7.1. Phase 1: Acoustic phonetic analysis of sub vocal utterances.

Phase 1 compared and analysed participant SV utterances with normal speech and whisper. The literature presents a range of studies pertinent to exploration of sub vocalisation in the normal population (Metzler, 2008., Wang et al, 2012) but it was not possible to identify any studies attributing this form of phonation to people designated PMLD. Exploration of the acoustic phonetic characteristics of the nature and type of SV utterances produced by the research participants appears to be absent, identifying a gap in the corpus. Therefore there is a divergence between the findings of this study and current theoretical and practical knowledge of the linguistic and phonetic characteristics of SV utterances by people designated PMLD.

9.7.2 Phase 2: Intelligibility

Phase 2 explored listener intelligibility of participant SV utterances. It was not possible to identify any studies in the literature review that disclosed information relative to the

intelligibility of SV utterances by people designated PMLD. The understanding that PMLD individuals are pre-linguistic (Samuel and Pritchard, 2001., Simmons and Bayless,2008) and the difficulties in accessing and identifying their SV phonation has mitigated against any exploration of the nature of their SV utterances. There appears to be a gap in the corpus.

In Phase 2 where listener tests of intelligibility were conducted, listeners were designated familiar or naïve in relation to their exposure to SV utterances. Currently, a small body of evidence (in studies into dysarthric, unfamiliar or disordered speech) proposes that familiarity facilitates intelligibility (Borrie et al, 2011, Liss et all, 2002)). In this study, the benefits of familiarity were not established. Results of listeners tests using SV samples by the research participants showed no statistically significant differences between outcomes for naïve or familiar listeners.

9.7.3. Phase 3: Linguistic and developmental levels

As reported above, the literature review identified that previous research and theory ascribed the characteristic of pre-linguistic to individuals designated PMLD. In addition, they are believed to be developmentally profoundly delayed such that they operate in stages specific to infancy (Cunningham, 2016., Mansell, 2010).) where the pre-requisites for language acquisition of intentionality and object permanence are absent (Vlaskamp, (2005). In contrast, the 20 research participants designated PMLD demonstrated that they can and do use SV language, revealing their attainment of the delineated pre-requisites of intentionality and object permanence not recognized in current studies. These outcomes for the 20 research participants contradict the understanding reported in the literature that individuals designated PMLD are pre-

linguistic and profoundly developmentally delayed. The findings of this research are therefore contrary to those of other studies. The access to SV utterances, provided a data set containing audible evidence of abilities previously obscured. Consequently, there is a divergence between current understanding of the linguistic and developmental stages attributed to people designated PMLD and the findings for the 20 research participants in this study.

9.7.4. Phase 4: Using meaningful utterances

Phase 4 examined the ability of the research participants to use meaningful language, demonstrating this by evidence that they can express their own views, opinions, and ideas. In addition, during semi structured interviews, the research participants were required to respond with answers that were contextually appropriate (and therefore meaningful) and were able to do so. An ongoing debate in the literature reflects growing concerns about the right of self advocacy for people with learning disabilities and addresses the need for individuals designated PMLD to contribute their own views and opinions to decisions made about their own lives (Clarke and Moss, 2011., Franklin and Sloper, 2009., Roulstone and McLeod, 2011). For those designated PMLD, concerns are about the limitations on their abilities to communicate or express any contributions they may have, with additional consideration about their inability to formulate opinions, views, ideas. In Phase 4, the research participants demonstrated the ability to both formulate and express their opinions, views and ideas, not only contributing to decisions made by others but also independently expressing their own plans and intentions for the future. Their acquisition of language and abstract concepts enabled them to both formulate and convey views, opinions and ideas , demonstrating a contrast with the research studies that report the inability of PMLD

individuals to do so

9.8.The implications of the research findings.

The findings of the four phases of the study represent only the 20 research participants. However, as discussed above, the outcomes are at variance with current theories and literature about the pre-linguistic nature of individuals designated PMLD and their profound developmental delay. It is apparent for all 20 research participants that they are characterised by multiple physical and sensory impairments but the extent of their linguistic and development levels has been demonstrated as beyond the stages associated with infancy. While previous research has acknowledged the difficulties in assessing individuals with a multiplicity of impairments and no verbal speech (IASSID, 2016., Nakken and Vlaskamp, 2007) access to SV utterances has provided measures of competencies not otherwise evident. On the basis of their assessed linguistic and developmental competence, the 20 participants in the study do not meet the criteria for individuals with profound learning disabilities. They cannot be pre-intentional where they provide evidence of their intentional use of meaningful language, which in itself encompasses their acquisition of intentionality and object permanence, assumed to be absent in individuals designated PMLD (Barber, 1998., Grove et al, 1999., Vlaskamp, 2005). They cannot lack the social pre-requisites acknowledged as necessary for the use of language as communication, including turn taking and joint focus of interest (Keitel and Daum, 2013., Yoo et al, (2018) , made apparent in SV samples of exchanges with the researcher and other adults.

Due to the differences between the current theories and practice presented in the literature and the findings of this research, this study challenges the view that the 20

research participants designated PMLD are pre-linguistic and profoundly developmentally delayed. There is a very significant range of severe impairments, physical, sensory and neurological, represented by the 20 research participants across a range of aetiologies, yet language appears intact at the levels demonstrated, despite the absence of audible, verbal speech. That this is evident in 20 individuals designated PMLD, where the severity of their impairments renders them incapable of demonstrating observable competence beyond that of an infant, is significant. Where nothing else works properly, the effectiveness and efficiency with which language has been acquired suggests a robust resilience to the effects of impairments on language acquisition for these 20 children and young adults. Due to the multiplicity of profound physical and sensory disabilities represented by them it is easy to assume (and in some participants to know) that some degree of brain damage has occurred, supposedly inhibiting or limiting language acquisition, yet for these 20 individuals, the adaptive nature of the brain confounds expectations. The capacity of the brain to retained or recover the necessary function to acquire language implies healthy adaptability for the research participants. The extremes of disability and sensory and physical impairments represented by them do not appear to have obstructed completely the mechanisms that engender or develop language.

9.9. Implications for practice

9.9.1. Exposure to language

Audio samples in Phase 1, Phase 3 and Phase 4 provide evidence of the use of SV language by participants. Phase 3 examined the content of participant SV utterances, identifying acquisition of linguistic and developmental levels beyond 24 months, as shown by assessment outcomes on Performance Levels, Developmental Milestones

and Mean Length of Utterance. The development of SV language by the 20 research participants cannot be explained at this point, occurring apparently where specific language teaching has not been offered. However, exposure to language provided by those around them and by media sources may have contributed to their language development, as for normal children. Consequently, exposure to a rich and varied vocabulary and grammatical forms is recommended, providing models representative of language forms in advance of those associated with pre- linguistic and developmental stages represented in infants. An assumption of potential competence, particularly in language used to and around individuals may enhance their lives and their learning. Intervention in the form of the provision of a rich language environment, particularly during the early years for the research participants is recommended.

Evidence of their grasp of general knowledge in Phase 3 showed that participants are capable of gathering and processing information from their exposure to language and experiences, even although schools and homes had not intentionally taught this In many instances, learning appears to have occurred incidentally, as for example where participants could explain their understanding of Brexit or refer to the American election. The current presumption is that exposure to media sources such as TV and radio may have this information and/or participants heard discussions and comments on the subjects by adults around them. Although their learning capacity and learning style has not been established, the apparent ability to acquire knowledge incidentally argues for exposure to a wide range of experiences and media sources and adult directed information to provide opportunities where such learning may occur. Access to extended sources of information and to wider experiences applicable to language users is highly recommended for the research participants.

9.9.2. Assessment

Phase 3 used the SV utterances by the research participants to demonstrate previously unrecognised competencies and made assessment of linguistic and developmental levels viable. Although the extreme difficulties in obtaining a reliable assessment of people designated PMLD has been acknowledged (Luckasson and Nygren, 2012., Tassé, Nakken and Vlaskamp, 2007) information derived from the language content of participant SV utterances facilitated assessments in direct relationship to items in P Level descriptors, Developmental Milestones and Mean Length of Utterance This approach was language specific, without reference to observable behaviours inhibited by impairments. The advantages too of using precise questions to obtain specific responses to demonstrate what individuals do or do not know was seen to expedite detailed evaluation of acquired knowledge and understanding The benefits of this approach can be applied consistently where SV utterances function in the absence of verbal speech, not only informing teachers of the existing linguistic and developmental levels reached by participants, but also contributing to future curriculum planning. Assessment measures that make use of the content of SV utterances is recommended for the research participants.

9.9.3. Speech therapy

The outcomes of Phase 1, Phase 2 and Phase 3 of the research identified that the participants were producing SV utterances as words and sentences at linguistic and developmental levels in excess of 0-24 months. Their use of language could be demonstrated audibly. However, the acoustic phonetic analysis of SV utterances in

Phase 1 identified that articulatory targets could be missed and audible samples of SV utterances identified variations in intelligibility. For normal audible speech, where needed, recourse to speech therapy can bring about improvements across a range of problems. The potential for speech therapy to play a role in facilitating improvements in SV utterances is yet to be addressed. However, the advantages of doing so could have significant benefits to individuals who have never had their (SV) speech or articulation assessed or their utterances explored by speech therapists. It may be that methods and strategies available to SaLTs need to be adapted appropriately for the SV phonation of the research participants, targeting precisely areas for intervention and facilitating beneficial improvements for the research participants using SV phonation as communication.

9.9.4. Communication interventions

The results of Phase 2, Phase 3 and Phase 4 demonstrated that the 20 research participants are not pre- linguistic. All participants in the study demonstrated acquisition of meaningful language and developmental levels in excess of those attributed to individuals designated PMLD. Data clearly identified that the research participants are able to use symbolic and abstract concepts in the form of SV language. The implications for speech therapists and teachers who chose communication interventions for the research participants are significant. Goldbart (2014) reports reliance by Speech Therapists on pre-linguistic interventions for individuals designated PMLD (where mother-infant communication provides the model for teaching) although research evidence for the effectiveness of this approach is, as yet, limited (Goldbart et al 2014, Hutchinson and Brodicoat 2014.) For the research participants, where language has been acquired, reliance on pre--linguistic

communication interventions may underestimate their competence, restricting rather than developing their abilities. The use of communication interventions that are not directed at pre-linguistic stages is recommended for the participants in this study.

9.9.5. SV utterances as communication

In Phase 3 and Phase 4 of the research, audio samples of SV utterances by the research participants showed the use of SV utterances as communication and Phase 2 demonstrated the abilities of listeners to perceive SV utterances as intelligible. Using playback of their recorded utterances the research participants engaged in conversations with the researcher, conveyed messages to others, responded in question and answer sessions and contributed spontaneous commentaries on subjects of their own choosing. Additionally, SV utterances enabled participants to express their own needs and wants and to advocate for themselves. In contrast to any other communication interventions available to them. Access to SV utterances also offered the research participants the opportunity to use their own vocabulary, grammar, intonation and choice of subject. The prerogative for what and how they constructed their SV utterances lay with the participants and was not defined by the limited subject matter and vocabulary determined by others around them. In addition, the use of SV utterances corresponds with the language used around the research participants and is common to that of normal peers and adults. Despite reliance on the researcher or other adults to facilitate recordings for the research participants, the use of recorded SV utterances as a communication intervention for the participants is recommended.

9.9.6. AAC devices

Issacson and Quist (2011) acknowledge the current understanding that people designated PMLD lack the linguistic and developmental competence to use AAC devices and are therefore often excluded from use of these AAC interventions. However, the outcomes of Phase 3 and Phase 4 showing developmental and linguistic levels beyond 24 months support the recognition that the necessary language and developmental level has been acquired by the research participants. This data enables a consideration of the provision of AAC methods , drawing on a wider range of communication devices than those presently made available. Despite the range and degree of impairment that typifies the research participants, language based AAC systems, appropriately adapted, are recommended.

In this research, recording and amplifying SV utterance operates as an AAC system that is disadvantaged by the software (which is not designed to record inaudible sound) and the delay in accessing participant utterances while recordings are amplified and processed prior to playback. The development of a device to record and playback utterances audibly and in real time is highly recommended.

9.9.7. Symbolic systems – signs, symbols, objects, graphic representations

Phase 3 and Phase 4 demonstrated the use of abstract concepts and symbolic representation in SV utterances, confirming developmental and linguistic levels beyond 24 months. The literature reported the use of communication interventions with individuals designated PMLD that assume a degree of symbolic representation

(despite difficulties in assessing this) in the form of symbols, objects, pictures and language. All phases of the study demonstrate that participants must have achieved symbolic representation and such approaches are entirely commensurate with the abilities displayed in the research. Thus for the research participants, such interventions are developmentally appropriate, although hindered by the physical and sensory impairments of participants in accessing the required equipment or materials. Nevertheless, where meaningful language is already present as demonstrated in participant SV utterances, such systems (adapted to overcome impairments) may be of benefit either as a communication strategy or to supplement and expand the use of existing SV competences.

9.9.8. Self Advocacy

In association with the outcomes of Phase 3 and Phase 4 where the research participants communicated using their SV utterances, their ability to advocate on their own behalf was also demonstrated. The use of SV utterances to facilitate participant self advocacy is recommended, reflecting the Revised SEN Code of Practice (2015) in conjunction with the Children and Families Act (2014) endorsing the principle that children with learning disabilities should be supported in contributing to planning decisions for their present and future needs. The research participants have demonstrated their ability to communicate and advocate on their own behalf and their right to do so should be facilitated.

9.9.9. Auditory feedback

Phase 1 explored the acoustic and phonetic features of SV utterances and identified

the failure of participants to hit articulatory targets consistently. Phase 3 identified that research participants had never heard their own voice out loud (prior to hearing amplified recordings). The causes of mis-articulation are many and varied in normal and disabled speech but the inability to hear their own speech sounds can be detrimental to a speaker. Chapman and Willidsen (2011) note that early (normal) words may not be adult like in terms of sounds or syllable shapes, characterised by the child's efforts to systematically reproduce the adult target, but with varying degrees of success (Menn and Stoel-Gammon 2005., Vihman, 1996.) Increasingly, the child develops the systematic phonology that replaces earlier mismatches to produce all sounds correctly. Auditory feedback contributes to the process, enabling the child to hear and adapt their own efforts to match the target sound. Where their own audible speech is absent, as for participants in this research prior to recording utterances (and also often evident in hearing impaired speakers) the process may be disrupted. The opportunity to refine and adapt the developing phonology is lacking, to the detriment of articulatory efforts and subsequent intelligibility. Participants in this research took great pleasure in using the Sound Box, which played back for them their own SV utterances in real time. In conversations with the researcher, participants indicated that this was a novel experience for them as was directly hearing their own amplified utterances. Previously, their inability to produce audible sound when producing SV utterances inevitably limited the extent to which participants heard feedback of their own SV phonation and therefore limited the extent to which they could adjust and adapt their phonation. Use of the Sound Box by participants, providing immediate auditory feedback of their own utterances potentially offers the means for adjustment and adaptation of phonological and articulatory effort to reduce the type and degree of mis-articulation. An investigation of improvement or otherwise in SV phonation and

consequent intelligibility in association with use of the Sound Box or other form of audible feedback of SV phonation is recommended..

9.9.10. Listener training

Liss et al (2002) propose the benefit of training to improve perception of dysarthric speech and this approach may have relevance for SV listeners. Training enables the listener to re-map phonological information to facilitate perceptual processing (Eisner & McQueen, 2005., Samuel & Kraljic, 2009.) Francis, et al. (2007) attribute perceptual gains from the effects of training to the way in which cognitive resources are redirected to informative cues in the sound signal. Attention shifts to the relevant cues, disregarding less relevant cues in the process. As training proceeds, effort required for working memory reduces to facilitate improved recognition (Francis & Nusbaum, 2009) where listeners can anticipate and focus attention appropriately to extract required information. Training and familiarisation with atypical phonation subsequently contributes to improvement in perceptual processing.. Specific training to enable listeners to experience SV utterances, thereby adapting their perceptual strategies prior to efforts to improve listener intelligibility of the participants' SV utterances is recommended.

9.10. Implications for future research

9.10.1.Sub vocal utterances

The absence of current literature (as identified in the Literature Review) in the corpus, and of appropriate data, describing or commenting on the use of sub vocal phonation by people designated PMLD, identifies the lack of awareness and theoretical

explanation of this phenomenon. Further robust research is needed to extend and explore this phenomenon beyond the initial investigation undertaken in this study.

The outcomes of this thesis suggests areas in which additional research priorities should be identified and further studies undertaken. They are presented below.

9.10.2. Prevalence

The data resulting from this research represents the participants contributing to it and results must be interpreted with reference to them. It is not possible to know how representative this group are to the overall population designated PMLD and the prevalence of SV utterances among them. Wider and further research is needed to ascertain if the results of this study are applicable to other individuals and populations similarly designated. Although the research provides evidence of the use of SV utterances by 20 participants, conclusions cannot be generalized to the wider population with similar impairments without additional and more extensive investigation. Further research is therefore essential in order to explore, quantify and evaluated potential evidence of the prevalence of this phenomenon in a wider, larger and more diverse population designated PMLD.

9.10.3. Language development

In Phase 4, findings identified the failure of participants to indicate how and when their SV language had arisen suggesting an accumulative development rather than any specific point at which this had occurred. However, evidence that this is the case is absent. . The research participants appear to have acquired language as do all children despite no direct efforts to teach them but isolated in their attempts to

consolidate and use it. No individual participant was consciously aware of the process of learning language or learning to follow and use grammatical rules, applied to new and innovative phrases. In contrast to normal children, their inaudible words had not been extended or developed by adults to achieve better and higher forms of language. They had not been engaged in conversations or social exchanges dependent on language rules and procedures. They had not used language to express needs and wants. Exploration of the acquisition and use of SV utterances by the research participants, in conjunction with theories of language development offer opportunities for further research to establish a theoretic basis for their previously unexplored language acquisition.

9.10.4. Verbal language

The literature describing the characteristics of individuals designated PMLD encompasses 'pre-verbal' as an attribute of their developmental delay. For participants in this research, their failure to speak aloud maintained the description as an obvious consequence of their failure to be audible and their inability to articulate verbal utterances. However, amplified SV utterances provided evidence of meaningful verbal language, albeit artificially generated from inaudible to audible. Participants then became 'verbal' although unable to speak aloud without this assistance. Thus, although the designation of pre-verbal correctly reflected their inability to produce audible speech unaided, this did not reflect developmental delay or their failure to conceptualise, use and understand (and want to use) audible words. Due to the uniqueness of this phenomenon, it is not possible to determine whether participants in this study might continue to be considered as developmentally pre-verbal, or if in view of the evidence of their amplified SV utterances might instead be recognized as

‘verbal.’ The opportunity to research this aspect of the phenomenon of SV utterances by the research participants is needed for further clarification.

9.10.5. Motor speech research.

The literature review identified that current research into motor speech development and impairment lacks reference to sub vocal phonation in people designated PMLD. The inability of the 20 research participants to produce verbal speech, yet with the ability to produce sub vocal utterances, offers an opportunity to compare and describe what is occurring. Research into the operation of the speech structures associated with SV performance and the integration of the systems and sub systems producing SV phonation in the participants designated PMLD is absent, yet outcomes of this research evidence their occurrence. Further research to compare speech motor functions producing verbal utterances with those producing SV utterances by individuals designated PMLD may extend understanding of the phenomenon. Moreover, in view of the failure of participants to demonstrate movement of the primary articulators when producing SV utterances, examination of systems contributing to the muscular contractions in the speech structures, possibly in combination with air flow or tongue movements may clarify processes currently unreported, illuminating how the SV utterances are achieved by the participants..

9.10.6. Listener intelligibility

The ability of listeners (demonstrated in Phase 2) to perceive meaning in phonation where movement of the primary articulators is absent requires investigation. Production of labial and bilabial sounds have been perceived as present by listeners in intelligibility tests in Phase 2, despite the observed lack of movement of the primary

articulators that typically produce them (Ladefoged and Maddieson,1996). Further investigation and assessment of the intelligibility of these sounds could contribute to a better understanding of the process producing them. Using the known language output to examine what participants can and cannot do could provide insight into other ways in which they achieve the acoustic phonetic outcomes that are intelligible to listeners. Despite the severity and complexity of their impairments, SV speech sounds are engendered by participants, in ways currently unexplored yet related in some way to normal speech and whispers as shown in Phase 1, where comparison of SV utterances with normal speech and whisper was undertaken. .

9.10.7. Respiratory support

The results of Phase 1 showed the lack of energy in participant SV samples (Fig.5.4.) in comparison with those of the researcher, and a range of recorded utterances demonstrated the lack of respiratory energy available to participants. The influence of respiratory-phonatory efforts on speech has been acknowledged. Miller (2018) notes the need to evaluate respiratory support and control for speech, acknowledging that, in normal speech, respiration functions to fill the lungs fully with air to enable controlled exhalation for speech. Poor or insufficient respiration, as observed in the research participants may inhibit or distort this process.

Portalete et al (2019) report respiratory rehabilitation, focussed on postural adjustments and diaphragmatic breathing to develop strength by sequences of fast/slow breathing to learn to control exhalation. The existing difficulties in participants in controlling any of their motor functions including respiration may be insurmountable but postural positioning as suggested by Portalete et al has been identified as

advantageous during recording sessions. Participants are unable to adjust their own posture but when positioned in an upright frame , rather than sitting (often slouched) in a wheelchair, individuals appeared to have more breath available for utterances, improving the duration and (SV) amplitude of their efforts. One participant extended the duration as well as the amplitude of his efforts when staff held his head upright for him (from a prone position).

During the course of this research, efforts to develop a pressure detecting system to identify variables of inhalation or exhalation in association with SV activity (Stacey, 2017) were instigated but outcomes were unreliable. Inadequacies of the mask intended to measure these variables allowed loss of pressure and therefore negated efforts to measure respiratory activity. However, further research to identify a more efficient way to do so with a better fitting mask potentially offers the means to examine the number of words/breath unit, including pauses within and between words, measured and described in relation to intelligibility and length of utterance. If respiration is shown to influence intelligibility and/or utterance length, research to identify strategies to improve respiration is recommended.

9.10.8. Effects of impairments

The evidence of meaningful utterances in the 20 research participants is notable despite the range of severe motor, neurological and sensory impairments that typify them and notwithstanding the global effects on all other impairments evident in all participants. The linguistic and developmental levels demonstrated by the content of participant SV utterances indicate the extent to which language development can occur and be maintained in the participants, even where major deficits are apparent

in other areas of the body and where a range of aetiologies are evident. Continuing exploration of their SV utterances is recommended in order to quantify the existing and future extent of their language acquisition in association with the varied impairments and disabilities that participants represent.

9.11. Strengths and limitations of the research.

Strengths

9.11.1 Original research

It is important to state that it has not been possible to identify any other research that identifies or explores the linguistic abilities in the form of SV utterances by children and young adults designated PMLD. This study was undertaken as original research and identified previously unrecognised linguistic and intellectual abilities in the 20 research participants. The key findings that the 20 research participants can produce meaningful SV utterances intelligible to listeners, linguistically and developmentally in excess of levels attributed to infants contributes original knowledge presently absent from the corpus. The results of the study directly contradict many of the previous assumptions about the characteristics attributed to the 20 research participants designated PMLD.

9.11.2. Consent issues

Iacono (2006 and Boxall & Ralph (2009) report that research into the needs of individuals designated PMLD has been limited by difficulties in obtaining consent. Iacono (2006) and Boxall & Ralph (2009) report that increased regulation and ethical concerns about the inability of PMLD participants to consent reduces the willingness

of researchers to engage in PMLD studies. In contrast, the research participants in this study could demonstrate their willingness to be included in this research by their own SV responses, ensuring that it was clear that they were willing to participate. Although currently individuals designated PMLD at any age cannot give their own consent independently, where SV utterances can be accessed, the research participants could make clear their wishes, an option of significant benefit to them and any potential future research.

9.11.3. The use of recorded SV utterances

The original use of participant amplified SV utterances as data is a major strength of this research. Data derived from utterances enabled instrumental analysis of acoustic/phonetic characteristics of SV phonation, and provided the required range of samples to construct listener tests of intelligibility. The content of SV utterances demonstrated the developmental and linguistic abilities of participants, enabling studies to converge to provide the weight of evidence that SV utterances were words, meaningful, linguistic, and intelligible. Participant contributions, also presented as recorded data, provided insight into the experience and consequences of using this form of phonation for the children and young adults working with the researcher, while demonstrating the meaningful nature of their utterances. Consequently, although the data type was limited, the information it provided was extensive.

9.11.4. Participant contributions

Research into the production of SV utterances by people designated PMLD is entirely absent from the corpus. The exploration of this phenomenon and issues arising from

it presents a view of individuals designated PMLD that remains largely unexplored. The contribution of participants has facilitated quantitative analysis of objective data in conjunction with examination of qualitative data that reflected the human experience of the participants in this study. Their utterances represent an unusual addition to a research area that generally lacks any direct input from those it investigates. The addition of audible samples of SV utterances by participants to illustrate and illuminate the research are an added strength, supplementing the weight of evidence provided by the four studies. The ability and willingness of the research participants to contribute to the research has been a major strength, contradicting much of what is currently assumed to be true about them. The 20 children and young adults are not, as currently presented in the corpus, comprised of behaviours and abilities reflective of neonates, operating only by the assumptions conferred on them by others.

9.11.5. Limitations in the literature search

The study was limited by the lack of research into the use of SV utterances by people designated PMLD. Opportunities for precise planning were limited by the difficulties in identifying previous research in this area. References to this phenomenon are absent from the corpus, so that there was no specific literature to draw on and no direct references available. The range and type of sub vocal phonation in PMLD people remains unknown as, until this was investigated as part of this research, it has not been identified in the corpus. As described by Shearer (1982) uncertainties about appropriate research methodology, both process and content were evident, further compounded by difficulties in expanding the initial literature search as few or no direct references applicable to the use of sub vocal phonation by PMLD people were available. Decisions about methodology drew upon studies in normal and disabled

speech, assuming rather than recognizing convergence. Consequently, the research was disadvantaged by a significant lack of background information, literature or previous research specific to SV utterances by individuals designated PMLD upon which the investigation could draw. This has restricted the development of the investigation to a more narrow focus than might have been possible otherwise.

9.11.6. Quality of the recordings

The vast majority of data for this research was drawn from recorded samples of participant SV utterances as other evidence of the competence of participants is conspicuously absent. This resulted in a heavy reliance on recorded SV utterances as a data source and on the equipment that made this possible. The microphones and the computer software were not designed to record SV utterances inaudible to the human ear. That they did so enabled access to SV utterances but also incorporated difficulties in ensuring the quality of recordings. The audibility of amplified samples was inevitably variable. The use of VSTs/plug-ins to clean and improve quality was essential, without which many of the SV utterances would have been inaccessible. Nevertheless, even where the quality of SV samples could be improved, they are far from ideal and recognised as a limitation in this research.

9.11.7. Transcription

The researcher transcribed all utterances. As Hustad and Cahill (2003) have shown, repeated exposure to dysarthric speech results in higher estimates of intelligibility. It is possible, therefore, that intelligibility levels of participant SV samples used in this research were inflated due to the familiarity of the researcher with SV phonation.

However, despite her experience as a listener, there was always a margin for error due to the poor quality of recordings or transcriber errors. Speech sound errors may occur in any language samples (normal or disordered) and there is an inevitable reliance on both the context and the ear of the listener to transcribe correctly. As noted previously, this is not BBC English with all the articulatory precision and technical proficiency that accompanies broadcasting. Nevertheless, the presence of words, phrases and sentences as SV utterances are evident and presented as audio samples in conjunction with the written transcriptions.

9.11.8. Variables in participant characteristics

The designation PMLD is, as indicated earlier, non-specific in terms of the underlying aetiologies of participants. Warren, Brady and Fey (2004) note the difficulty in ensuring a homogenous sample for this population and the range of medical diagnoses and conditions attributed to this participant set is wide. The influence or otherwise of differing aetiologies, impairments and conditions could not be isolated, therefore introducing unintentional and uncontrollable variables with and between participants.

As all participants were still in education, the age range was limited (3- 20 years) so that older individuals were not represented. Ethnic minorities were also under-represented with only two participants from ethnic minority backgrounds, but the requirement for living in an English speaking environment may have been unintentionally restrictive. The relationship to social class was not investigated and the influence of this factor could not be considered. Participants were drawn from a limited geographical area in the UK as the logistics of transporting individuals were restrictive. Their characteristics and experiences may not be representative of a wider population

and findings cannot be generalised as a result.

9.11.9. Listener Test design

The design of listener tests of intelligibility was impeded by the unique nature of SV phonation by children and young adults designated PMLD and by their lack of audible speech. These characteristics are not represented in current research into listener intelligibility. Inevitably, studies exploring speech and listener intelligibility are based on exploration of speech by people who can speak, albeit often producing atypical or dysarthric speech. In this research the inability of participants to produce verbal outcomes and their presumed linguistic and developmental delay placed them outside the parameters of existing listener intelligibility studies. Consequently, the design of Intelligibility tests has been based on listener intelligibility of impaired speakers to guide the methodology (Beukelman et al 2011., Lansford et al. McHenry 2011) The results therefore may be limited. More extensive research to establish more extensive data is needed to ensure that listener tests are suitable and appropriate to SV utterances by people designated PMLD.

9.11.10. Test materials

Some criticism of the test materials used in Phase 2 is apposite. In comparison with commonly used assessments that have been validated and standardized, exploration of listener intelligibility in Phase 2 has been exploratory and pragmatic. Test materials used in Phase 2 could not be norm referenced due to the uniqueness of the phenomenon of SV utterances by individuals designated PMLD. Test scores could not be compared to the performance results of any other group as the existence of SV

utterances has not been previously recognised or tested. In addition, the reliability and validity of test outcomes could not be determined as tests were constructed and pragmatically adapted for the abilities that participants could demonstrate. Their inability to read sentences or word lists, commonly used in tests of intelligibility such as the Assessment of Intelligibility of Dysarthric Speech (Yorkston and Beukelman, 1981) constrained options. In contrast, samples used in closed tests presented variations in phonetic construction or semantic context, selected according to the word samples available, rather than as a consequence of an intended research design. Consequently, choice of samples was dependent on achieving recordings of sufficient audible quality rather than collecting samples to isolate variables to facilitate the description and comparison of utterances. Thus, although tests measured listener intelligibility in a range of conditions, other variables that might influence the ability of listeners to recover information could not be easily factored into pre-selected word samples. Test outcomes were therefore essentially determined using a threshold of above chance recovery of words by listeners, predicated on the proposal that intelligible content must be present for samples to be correctly perceived.

9.11.11. Disadvantages of SV utterances as research data.

Currently, although there are advantages in the use of SV utterances as data for this research, there are also limitations. Obtaining good quality samples requires some skill so that the intelligibility of samples is variable and a disadvantage is apparent due to the delay in accessing utterances in real time. The time lapse between production of the utterance and listener access to it has negative implications for the efficiency of this mode of communication, inhibiting the free flow of conversational exchange and

delaying access to the comments made by participants. The software is expensive too and, for users who are unfamiliar with this technology, may appear difficult to use. However, the use of SV utterances operated without any specific physical or sensory abilities by the research participants, appearing to benefit from good respiration but not requiring it.

9.12. The impact of the research on the participants

This thesis was designed to explore the hypothesis that children and young adults designated PMLD could produce meaningful SV utterances intelligible to listeners. Based on the results of this research, evidence was collated to prove that the research participants in this study can do so. This section presents what this result means in their lives . It contrasts current assumptions about their abilities with the understanding derived from the findings of this research and therefore the recognition of the competence of the 20 children and young adults contributing to this research.

The recognition of the production of meaningful SV utterances by 20 participants in this research challenges existing assumptions about them. Educationally, they were assessed at or below Performance Level P4 and all exhibit an inability to respond to P Level assessment criteria above this level. However, as this study demonstrates, they have acquired language, thereby demonstrating developmental and linguistic levels above P4 and negating previous assessment outcomes. The recording and amplification of their SV utterances has made clear that they do not operate as infants. All participants have shown themselves to be capable of conversing meaningfully with the researcher, using properly constructed sentences to express their needs and wants and communicating their knowledge and understanding of the world around

them.

The language and the developmental levels demonstrated by the participants confounds the limited expectations attributed to the research participants.. This means that the research participants in this study are now recognised as more intellectually and linguistically able than previously recognised. Consequently, social and learning experiences for them are now constructed in ways that acknowledge and capitalise on this finding. During and subsequent to the research, the findings of the research have had positive consequences for the research participants. Most significantly, demonstration of their ability to use SV utterances and the content included in them resulted in a reconsideration of their needs. The outcomes were wide ranging.

Following the research outcomes, equipment, resources and staff have been provided to implement the use of recorded SV utterances in classes where participants in this study are taught. A more advanced curriculum offer has resulted, with teachers able to deliver a curriculum that recognises the competence of their pupils. Staff training has been implemented to facilitate digital recording of SV utterances, enabling participants to maintain and extend this as a method of communication in the classroom. Presentations to whole school meetings to explain and demonstrate the research has ensured that all staff, directly or indirectly associated with the participants, are able to recognise and acknowledged the competence revealed in SV utterances. The current aim is to embed the use of SV utterances into the curriculum for the research participants, facilitating this as both a communication intervention and an on-going assessment. Development of this approach is currently monitored to provide feedback with a view to potential expansion and improvement of this method

to other PMLD individuals not yet included in the research cohort.

The demonstrated use of SV utterances has also contributed to assessments, where the nature of SV utterances identified stages and levels of linguistic and developmental achievement previously obscured. Assessment outcomes have been included in formal reports so that information and evidence provided by the content of SV utterances have been used to better identify linguistic and developmental levels of individuals. Parents too, after hearing their children's SV utterances and reading their transcripts and reports have commonly reported changes in their expectations of their children, using higher levels of language to them, explaining more to them, and offering more appropriate activities to them. Parents have expressed their appreciation of a more realistic understanding of the competence of their child, adapting their expectations in line with their child's demonstrated abilities.

The most significant impact has been on the participants, now able to comment on matters relevant to them, advocating on their own behalf. Their own opinions about respite care have been shared with the responsible agencies and issues of concern to participants have also been addressed, for example a concern about the speed of the transport vehicle and a range of worries related to health issues. It became apparent that for some participants with severe and complex medical problems, information overheard at medical appointments was distressing for them. The assumption that they lacked understanding was misguided, to their detriment. Similarly, the assumption that they lacked either knowledge or feelings around bereavement issues was misplaced. Following playback of utterances to hospice staff, advice and training for staff meeting the needs of participants enabled a better

recognition of how best to respond to bereavement and medical issues faced by participants.

9.13. Conclusion

The four phases of the research have produced data to show that 20 children and young adults designated PMLD do produce meaningful SV utterances intelligible to listeners. Phase 1 demonstrated that participant SV utterances do contain acoustic phonetic features that parallel those in normal speech and whisper. Phase 2 showed that the utterances were intelligible to naïve and familiar listeners. In Phase 3, the content and structure of their utterances identified linguistic and development levels in advance of those previously attributed to the research participants . In Phase 4, the content demonstrated the meaningful nature of participant SV utterances. The combined and collective outcomes of all phases identify the internal, non verbal language in the 20 participants that has developed and been expressed sub vocally. The lack of movement of the primary articulators or other observed behaviours to indicate language acquisition, in conjunction with the unintended consequences of sensory and physical impairments on assessment outcomes has obscured abilities, knowledge and understanding that can now be accessed for the 20 individuals contributing to this research..

Inevitably, the last word must belong to the participants in this study. The recognition of their meaningful SV language had obvious significance for their self-esteem and confidence. Despite the difficulties in recording and replaying their comments, they expressed their pride in being able to ‘speak’ and wanted others to

know.

Chapter 10 a sample

Participant 3: I can't write, but I can talk

Researcher: Is it ok to play your recordings to other people?

Participant 11: I asked you

Researcher: If other people listen to you, we won't tell them your name.

Participant 11: I like to say it

Participant 8: Here it is…the voice…and I'm proud of that

10: Reflections

This research has been a substantial piece of work that has occupied extensive periods of time over the previous 6 years. It has required a greater commitment and focus than had been anticipated but has developed and increased the academic competence of the researcher in a variety of ways. The organisation and management of data, including the collection and interpretation of required information has engendered familiarity with the tools necessary for the future extension of the current study in further and previously unexpected directions. In particular, outcomes of the current research can be utilized as the basis from which to develop communication systems for the research participants, capitalizing on their demonstrated language acquisition. Importantly too, the research has identified a means to assess the research participants, providing a precise and concise understanding of their needs. This information will facilitate future planning and implementation of detailed learning strategies for the children and young adults who have contributed to this research.

As a consequence of this research, knowledge and information about the linguistic and developmental levels of the research participants has been acquired, currently unknown to other professionals and academics working with this population. The researcher is now able to offer relevant data, tools and techniques to enable others to replicate and extend the initial investigation. In completing this research as an extensive academic study, it has been necessary to ensure the integrity of the investigation and the credibility of the results. I feel that the scope and the structure of the research has met that aim.

The process and outcomes of the research has challenged my own perceptions and understanding of individuals designated PMLD. As the Head Teacher of a number of

special schools I have had extensive experience of this population, yet not recognised the linguistic and developmental competencies previously obscured by the severity of their physical and sensory impairments. In gaining access to their SV utterances, it has been both a pleasure and a privilege to acknowledge the abilities the participants have displayed and the personalities they have exhibited in our joint exchanges. In view of this, my awareness of the paucity of experiences and the misunderstanding of the potential abilities of the research participants has changed both my professional and personal relationships with the children and young adults with whom I work.

The most significant repercussions of this research pertain to the participants and I have reflected on the implications for them. The experience of demonstrating their SV language has been positive, substantially changing how others relate to them and therefore how they see themselves. The process of this research has given them the opportunity to communicate (using their SV utterances) in ways that have been unavailable to them previously. I am pleased to have provided the opportunities for them to do so and to have made a positive contribution to their lives.

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Appendices

Appendix I: Girimaji and Pradeep, 2018. Approaches to Intellectual Disability

Comparison between International Classification of Diseases- 11 and Diagnostic and Statistical Manual of Mental Disorders-5 Approaches to Intellectual Disability. (Girimaji and Pradeep, 2018)

Domain of ID	ICD-11	DSM-5
Terminology	DID	IDD
Placement	Neurodevelopmental disorders	Neurodevelopmental disorders
Approach taken	Disorder approach (health condition)	Disorder approach (health condition)
Defining feature	Below average intellectual functioning and adaptive behavior that are approximately two or more SDs below the mean (approximately less than the 2.3rd percentile), based on appropriately normed, individually administered standardized tests. Where appropriately normed and standardized tests are not available, diagnosis of disorders of intellectual development requires greater reliance on clinical judgment based on appropriate assessment of comparable behavioral indicators. Intellectual function and adaptive function deficits - assessed by standardized tests; clinical assessment if tests not available	Intellectual function and adaptive function deficits confirmed by both clinical assessment and individualized, standardized intelligence testing
Adaptive behavior	Defined in terms of conceptual, practical and social domains	Defined in terms of conceptual, practical and social domains
Subclassification	Based on intellectual function and adaptive behaviora assessment	Based on adaptive function abilities
	Mild, moderate, severe and profound based on Intellectual and adaptive function deficit (based on standardized testing and if not available clinical assessment can be used for classification)	Mild, moderate, severe and profound based on adaptive function ability (based on adaptive function assessment clinically)
	Provisional and unspecified type included	Unspecified type and global developmental delay included
Comorbidity	Presence of co-occurring neurodevelopmental disorders and other psychiatric disorders, including problem behavior is explained. Category of provisional DID has been added which includes individuals in whom formal assessment is difficult due to comorbid conditions	Presence of co-occurring conditions and their impact on assessment explained
		Category of unspecified IDD has been included which includes individuals in whom formal assessment is difficult due to comorbid conditions
Developmental perspective	Provides detailed clinical behavioral indicators of various intellectual and adaptive behavior skill attainments across the various developmental stages from childhood, adolescence to adulthood	Based on adaptive function domains, various skill attainment among individuals in each type through various developmental phase is provided but no clear distinction in three domains explained as in ICD-11
	Provisional DID is included to consider children under 4 years, where formal assessment difficult due to sensory, motor impairments and due to comorbidities and problem behavior	
	Importance of early support and interventions with need for multiple assessments over longitudinal developmental trajectory has been explained	For children under 5 years and where formal assessment difficult, global developmental delay concept is provided and unspecified IDD is used to classify individuals with significant problem behaviour/co morbidity, if associated sensory, motor impairment and more than 5 years of age
		Acknowledges the impact of early intervention in improvement of adaptive behaviour and acknowledges the need for multiple assessments over longitudinal period

ICD=International Classification of Diseases, DSM=Diagnostic and Statistical Manual of Mental Disorders, IDD=Intellectual developmental disorder, DID=Disorder of intellectual development

Appendix II: Initial Scoping

Broad scoping review:
Data bases scanned for sufficient relevant studies available for the literature review

Google scholar
Acoustic 2,76,000
Sub vocal 18,400
PMLD 99 sub vocal (music)
PMLD language 1,600
Communication 950
Intelligibility 25,000
Intelligibility sub vocal 1,330
Whispers 19,700
Whispers sub vocal 892
Vowels sub vocal 2,320
Formants sub vocal 3.76
PMLD developmental stages 1,830
PMLD linguistic stages 349

IEEE 29,993 – 11
Sub vocal 8.354.
Vowels 2,378
Learning disability, 8327
Whispers 28
Academic Search Premier 129
Scopus 956,449, vowels
28,150,speech sub vocal 398
Science Direct 12,515
SV vowels 1,732,
learning disabilities 116,
English speaking 67
PubMed 3,756/901 Dysarthria 35
CINAHL 26,653-1.442 1,066 vowels

Appendix lll: Sample- Notes on databases searched
What I did on databases and the search results

Database DMU Learning Services A-Z data base		NOTES Access to Taylor Francis costly!	Number found
EBSCO	CINAHL Plus with full text	Acoustic analysis of speech – vowels No results for Ray Kent vowel paper Search is limited - adapted key words –acoustic analysis of VOICE 2 identify Praat for methodology	90
IEEE X/plore	Wiley Library eBooks	Monthly alerts available Conference papers Must spell subvocalization with a Z	2
Elsevier	Scopus ScienceDirect	Slow to navigate – humanities and social science 2012-2020 Academic journal ratings available Some free preview – use DMU A-Z Single interface to eBooks	398
Academic Search Premier		SmartText searching for 2,760 - English makes search language specific as in foreign languages English 65	129
ERIC		Education specific. Check duplicating papers from other sites. Put on Refworks to remove duplicates if not sure Provided by US – only 9 for acoustics	9
MEDLINE PubMed		Acoustic vowel papers on dysarthria and Parkinson's 901– filtered for last 10 years – 22 US National Library of Medicine Abstracts and full texts – Access free	22
Ingenta SAGE		On-going problems with access even through De Montfort. Alerts are costly. Download Lean Library app. – not good	
Google Scholar		Ranks by relevance – enter limited time to save extensive searches that are not relevant Generally scholarly studies/articles but some sources not reliable	109 SV PMLD music

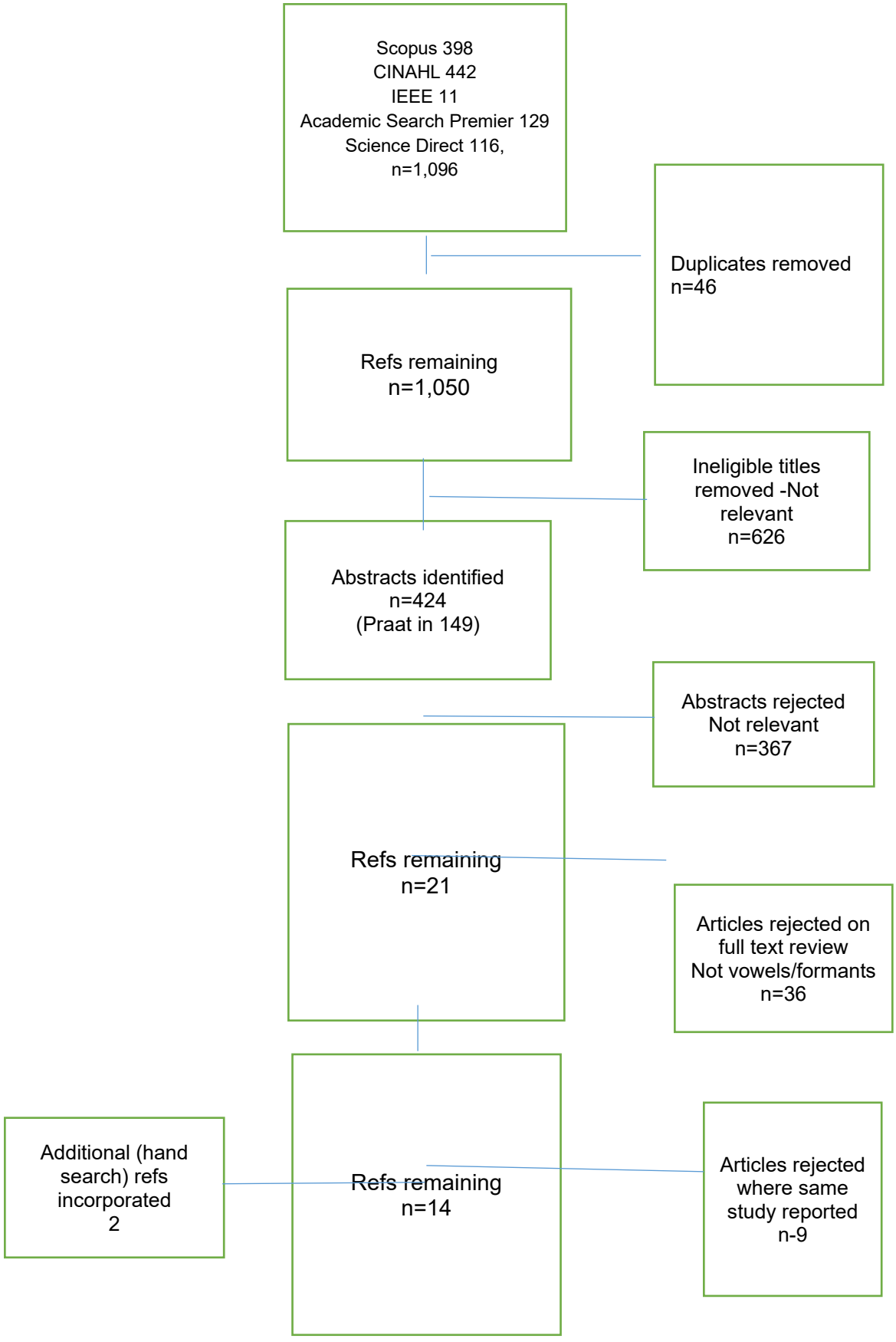
#

Appendix IV: Sample - Studies to be followed up

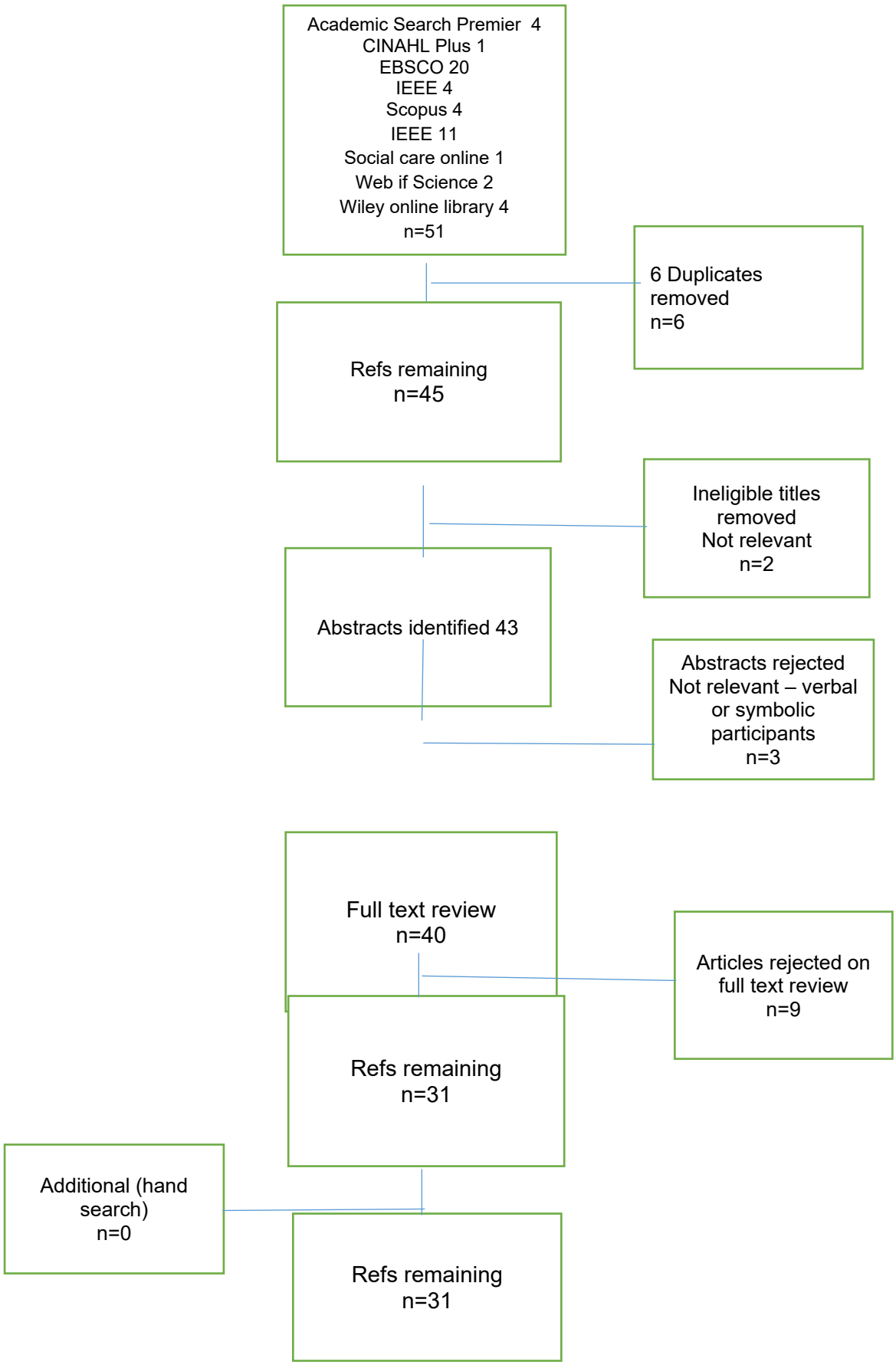
Database	Notes
Google Scholar	Communication Porter, Ouvry, Morgan & Downs (2001) No meaningful lang. Idiosyncratic communication diff. to interpret Interpreting the communication of people with profound and multiple learning difficulties', British Journal of Learning Disabilities, 29 (1), pp. 12-16. Nind, M. and Hewett, D. (1998) Intensive Interaction 'Access to Communication'. London: David Fulton. Presumes developmental level and communication at 0-24 months Simmons and Watson (2015) facial expressions As above idiosyncratic, assumption that intentionality is lacking and partner ascribes meaning
	Developmental delay Ware, 1996 Creating a Responsive Environment for People with Profound and Multiple Learning Difficulties', London: Fulton Hogg, J. (2004) 'Call for Papers for Special Issue of Journal of Policy and Practice in Intellectual Disabilities' Bellamy, Croot, Bush, Berry and Smith, 2010 (social development issues Samuel & Pritchard, 2001 The Ignored Minority: Meeting the Needs of People with Profound Learning Disability', Tizard Learning Disability Review, 6, pp. 34–44. -Social delay and social issues Simmons and Watson (2014 deficit model PMLD Ambiguity – check 2015 intersubjectivity' From Individualism to Co-construction and Back Again: Rethinking Research Methodology for Children with Profound and Multiple Learning Disabilities', Child Care in Practice, 21 (1), pp.50-66. Uzgiris, I. and Hunt, J.McV. (1975) Scales including intentionality ad causality – proposed pre-requisites for language 'Assessment in Infancy: ordinal scales of psychological development', Chicago: University of Illinois Press .Check assessment sheets for J1- discuss class assessments with NP

Appendix V: Sample - Flow Diagrams

Acoustic Analysis



Self advocacy PMLD:



Appendix VI: Critical Appraisal Table

Critical appraisal table

thor/Date rber M. (2008)
e Using intensive interaction to add to the palette of interactive possibilities in teacher-pupil communication. ropean Journal of Special Needs Education 23, 393– 402.
rity of research aim/s Was there a clear statement of aims? s, examining effects of Intensive Interaction on communicative behaviour of staff and pupils
rticipants/Sample (size , adequate, representative) originally but results for only 3 autistic pupils – gender not given. No explanation for missing participants. ssible researcher bias?
thods/methodology Was the methodology appropriate? it confusing due to investigation of staff and participants in the same study. Intervention (30 weeks of intensive eract)not v.specific and open to uncertainty about both quality and quantity of interventions by staff.
search design (suitable to the research questions) 3 using video to monitor – appropriate because changes in behaviour v.difficult to observe but video coding for ecific behaviours identifies before and after minimal change. Baseline established 12 months prior to intervention relationship to outcomes uncertain as results cannot be reliably linked to start of intervention when true baseline ght have altered.
ta collection and analysis. Was the data collection and analysis appropriate to address the research question. s, for communication for participants -used coding established by Nind (1996) for participants and analysed cording to specified behaviours. me uncertainty about the investigation into staff where required responses were not within a consistent mework
itations (re: application to the research) istic participants not representative of this study. Are they PMLD? Small numbers. Focus on staff as much as rticipants
y findings (consistent with the study aim) Is there a clear statement of findings? r participants, yes, because video coding is specific and therefore can show gains (but small considering this was 0 week intervention) dings Include staff team training and responses not applicable to my study.
olications for the research. sed on model of carer/infant identifying very limited communication but not clear if this an 'autistic' outcome or icative of profound developmental delay. Demonstrates very wide gap between Barber participants and those in research as do Intensive Interaction studies. intains the assumption of profound delay in PMLD. Categories of behaviours in interventions and results are egiver/infant

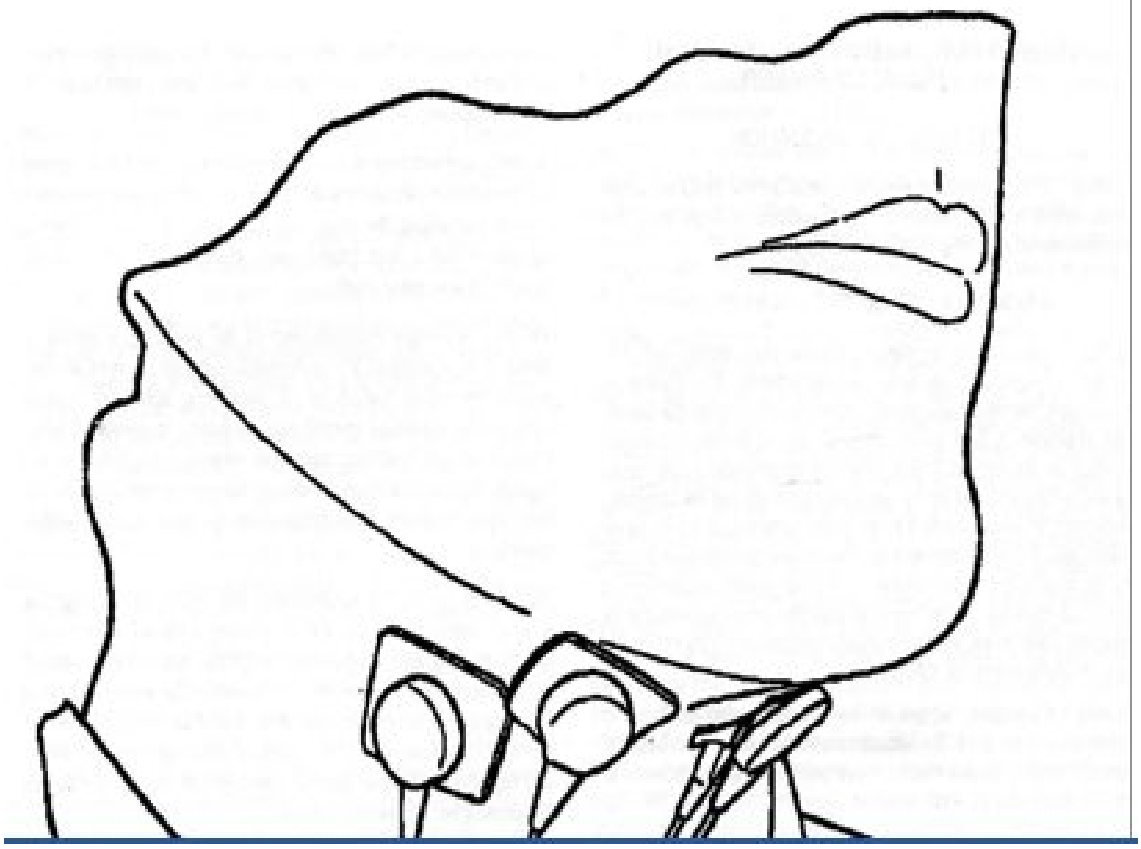
			Appendix VII: Data extraction table		
Author Title Year	Participants Sample Size	Aims/Research question	Results/ Key findings/conclusion	Methodological Critique	Stud
Bellamy,et al(2010).A study to define PMLD	23 normal adults, health care professions, services managers, care staff, carers	To define the term PMLD	Defined term for personal characteristics, diagnoses, disabilities/impairments/activities restrictions	Is the outcome time specific?	Lit re indiv inter focu
Ansel and Kent (1992) Acoustic phonetic contrasts and intelligibility in dysarthria associated with cerebral palsy	16 dysarthric adults	Evaluated perceptual judgements of specific acoustic features of speech for CP dysarthria.	Contrasting word tasks for intelligibility analysis and correlated acoustic analysis	Disordered speech but CP not PMLD	Anal eval intel trans and task
Yorkston and Beukelman (1983) The influence of judge familiarisation with the speaker on dysarthric speech intelligibility	9 participants with dysarthria	Compared for perceptual learning for two familiarization groups- control group n=3	No significant difference in intelligibility scores between familiarized and non familiarized listeners	Tools and methods detailed for intelligibility testing	AB c
Garcia and Cannito 1996 Top down influences on the intelligibility of a dysarthric speaker-natural gesture and situational context	1 participant Flaccid dysarthria 96 naïve (normal) listeners	Compared for audio, visual or audiovisual familiarization /non familiarization for perceptual learning	No significant difference for intelligibility scores for either familiar or non familiar	Small Participant numbers but 96 listeners under 3 varying conditions for direct comparison	AB a grou Man liste expe
Liss et al (2002) The effects of familiarisation on intelligibility and lexical segmentation	12 participants, moderate to severe dysarthria	Compared non-familiarised with familiarised listeners	Higher intelligibility scores for familiarised listeners	Hypokinetic and ataxic dysarthria specific- may not apply to other classes	Com grou AB c
D' Innocenzo et al Intelligibility in Dysarthria: Effects of listener familiarity and speaking condition.	1 participant (TBI) 100 listeners	Familiarisation; none	Significantly higher scores for familiarised with word list or paragraph	Small speaker participant numbers. Similarity to Liss (2002) but less evidence	large num acro conc
Cannito, M.P., Pfeiffer, M.R. (2011) Sentence Intelligibility Before and After Voice Treatment in	8 PD speakers	Effects of loudness on intelligibility	6 improved intelligibility with loudness, 2 did not	Specialist treatment programme to increase amplitude of	Rec sam to lis and loud

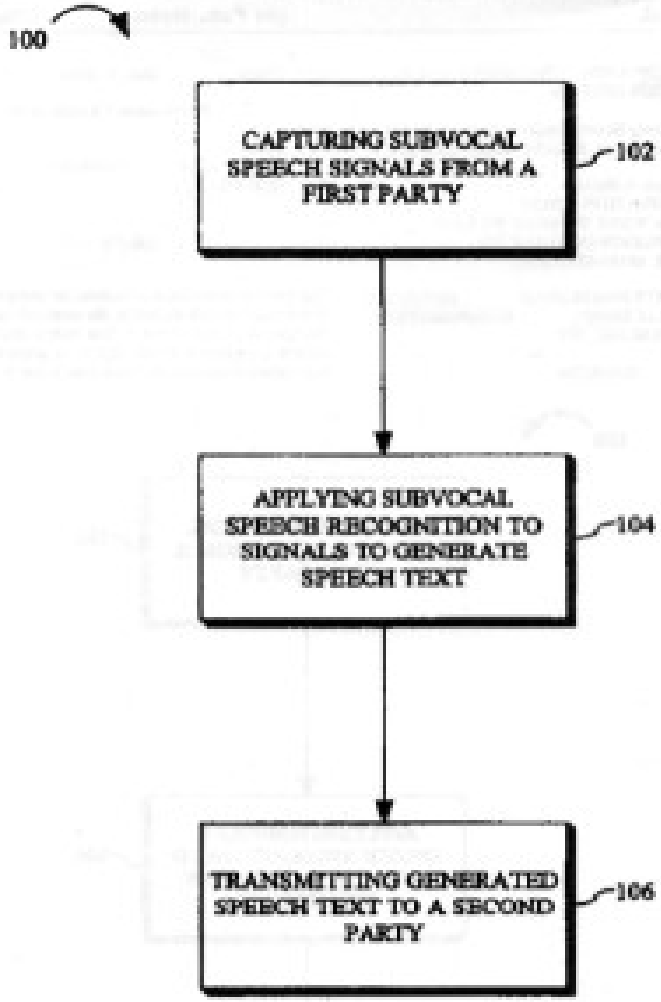
Speakers with Idiopathic Parkinson's Disease.				dysarthric speech with detailed methodology	Intel calcu and treat
Manabe & Zhang (2004) Multi-stream HMM for EMG-based speech recognition.	10 sub vocal speakers	Recognition of sub vocal phonation for 10 Japanese digits	Average rate of 64%	Normal SV speakers – how comparable to PMLD participants?	Elec read sign spee struc mus
Hein et al (2005) Session independent non-audible speech recognition using surface electromyography	3 speakers	Recognition of SV	97% EMG readings	Normal SV speakers – how comparable to PMLD participants?	sEM
Instrumental measures Meltzer et al (2008) Speech Recognition for Vocalized and Sub-vocal Modes of Production using Surface EMG Signals from the Neck and Face	1speaker 65 individuals words	Recognition of EMG signals on speech via speech musculature in comparison between vocal and sub vocal	96.7% for SV 86.7% for word vocabulary	Normal SV speakers – how comparable to PMLD participants?	sEM mea com betw and
Ephraim, G. W. E. (1979).Developmental processes in mental handicap: A generative structure approach.	SSN,	Effect of naturalistic interactions/ Mother infant		Individual case studies	
Nind 1996 Efficacy of Intensive Interaction	6 adults PMLD Institutionalised	Improve/increase non verbal social and communication behavious	Occurrence of previously absent social behaviours	Criticised for improvements not directly related to start of the intervention	Mult base vido
Kellet 2000 Sam's story: evaluating intensive interaction in terms of its effect on the social and communicative ability of a young child with severe learning difficulties	1 pre-verbal SN 5 year old	Demonstrate positive effects of Intensive interaction	Increased visual exploration/eye contact,physical contact, joint focus, contingent vocalising	Very small participant numbers not PMLD?	AB c Case
Kellet 2003 Jacob's journey: developing sociability and communication in a young boy with severe and complex learning difficulties using the intensive	1 SEN child with severe (not PMLD) delay	Efficacy of Intensive interaction	Increased engagement, facial exploration, joint focus	Variability in coded scores, limiting reliable outcomes	Trian vide verb Com Sche

interaction teaching approach					
Samual et al 2008 An evaluation of Intensive Interaction in community living setting for adult with profound intellectual disabilities	4 PMLD adults	Evaluate staff responses to participants	Increased engagement and visual scanning using video coding	Initial focus on staff rather than participants.	Obs for p
Barber 2008 Using Intensive Interaction to add to the palette of interactive possibilities in teacher pupil communication	11 participants	Evaluate changes in communication of staff and participants	Increased facial scanning, physical contact, smile for 1 participant	Reports only 3 participants (bias issues?)	AB d Base mon inter mak outc unce
Argyropoulou & Papoudi (2012) The training of a child with autism in a Greek preschool inclusive class through intensive interaction: a case study,	1 SEN child	Effects of \intensive interaction	Increased initiations from participant		Case
Zeedyk et al (2009) How rapidly does Intensive Interaction promote social engagement for adults with profound learning disabilities?	10 PMLD adults	Effects of intensive Interaction on Levels of social engagement	Increase on all measures in first interaction session	Some physical abilities in participants conducive to movements	Obs mult desi Cod
Calveley (2017) Gaining the power of initiation through Intensive Interaction	1 Non verbal 15 year old, physically disabled. Complex health needs	Effects on (pre-verbal) communication	More engaged Increased vocalisation, social behaviour, remained focused for longer		Case deve leve clari
Chambers and Rehfeldt (2003) Assessing the acquisition and generalisation of two mand forms with adults with severe developmental disabilities	4 adults Severe/ profound developmental delay	Comparison between effectiveness of PECS teaching with mand or signs	Achieved criterion performance using PECS	Some physical capacity present to handle materials – not reflective of research participants	Alter treat desi
Jones et al (2009) Developing communication in adults with profound and multiple learning	13 participants PMLD Adults	Effectiveness of objects of reference	Standard set of objects over 20 weeks achieved significant gains, plateau at 10 weeks and more progress at index level	Physical capacity needed for handling objects	AB r desi

difficulties using objects of reference					
Bracken, M. & Rohrer, N. (2014). Using an adapted form of the Picture Exchange Communication System to increase independent requesting in deafblind adults with learning disabilities,	3 Deaf blind adults 1 moderate LD 1 severe LD 1 PMLD	Effectiveness of PECs in independent requesting	All reached mastery criterion	Good range of participants but small numbers. Very detailed preparation and delivery, behavioural defined.	Mult base

Appendix VIII: Becker and Bustalo (2006) : Patent US 2006/0129394 A1)




100
CAPTURING SUBVOCAL SPEECH SIGNALS FROM A FIRST PARTY
102
APPLYING SUBVOCAL SPEECH RECOGNITION TO SIGNALS TO GENERATE SPEECH TEXT
104
TRANSMITTING GENERATED SPEECH TEXT TO A SECOND PARTY
106

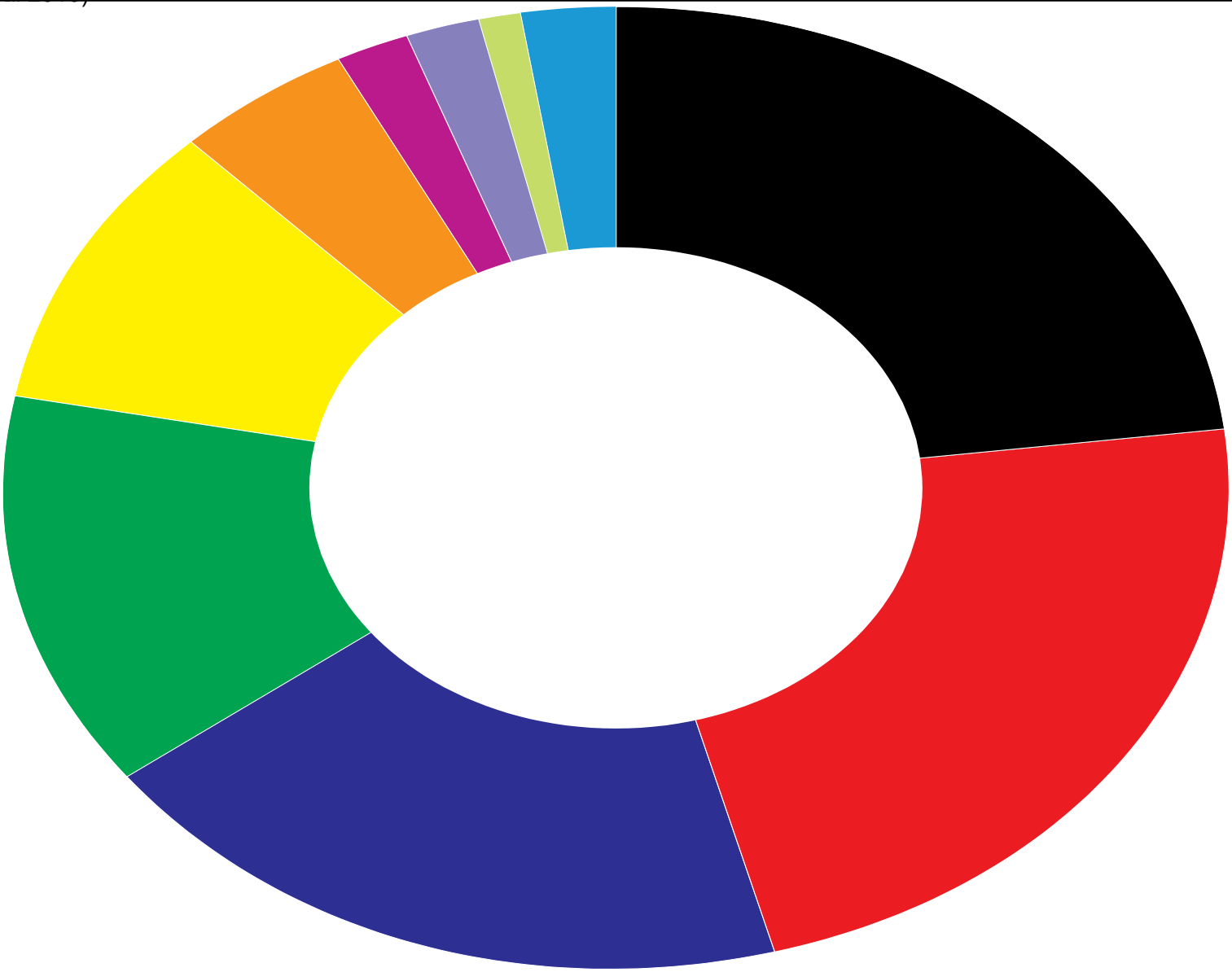
Appendix IX: Recognition results for vocalised and sub vocal speech.

Summary of recognition results for both vocalized and mouthed (sub vocal) speech. Metzler et al (2008)

	Vocalized Speech			Mouthed Speech	
	Digits	Full		Digits	Full
Subject	0-9	Vocabu- lary		0-9	Vocabulary
1	100.00%	88.50%		100.00%	88.50%
2	95.00%	93.10%		100.00%	84.60%
3	95.00%	90.00%		95.00%	89.20%
4	100.00%	91.50%		90.00%	82.30%
5	100.00%	96.20%		95.00%	92.30%
6	100.00%	96.90%		100.00%	92.30%
7	95.00%	96.90%		100.00%	89.20%
8	100.00%	84.60%		100.00%	90.80%
9	mrs100.0%	90.80%		90.00%	70.80%
Mean	98.30%	92.10%		96.70%	86.70%

Appendix X Total number of people who would benefit from AAC (Creer et al 2016)

The percentage of the total number of people who could benefit from AAC in terms of the individual conditions (Creer et al 2016)



Alzheimer's/dementia	23.2	%
Parkinson's disease	23.7	%
Autistic spectrum disorder	18.9	%
Stroke/CVA	13.3	%
Cerebral Palsy	9.9	%
Head/brain injury	4.5	%
PMLD	2	%
MND	2	%
Other [11]	1	%
	2.5	%

Appendix XI : Ethical Approval

DE MONTFORT
UNIVERSITY
LEICESTER HLS FREC Ref: 1163

20th August 2013

Rosemary Woods

Dear Rosemary,

Re: Ethics application -A Case Study in developing a vocal communication system (ref: 1163}

I am writing regarding your application for ethical approval for a research project titled to the above project. This project has been reviewed in accordance with the Operational Procedures for De Montfort University Faculty of Health and Life Sciences Research Ethics Committee. These procedures are available from the Faculty Research and Commercial Office upon your request.

I am pleased to inform you that ethical approval has now been granted by Chair's Action for your application . This will be reported at the next Faculty Research Committee, which is being held on 1st October .

Should there be any amendments to the research methods or persons involved with this project you must notify the Chair of the Faculty Research Ethics Committee immediately in writing. Serious or adverse events related to the conduct of the study need to be reported immediately to your Supervisor and the Chair of this Committ ee.

The Faculty Research Ethics Committee should be notified by e-ma il to HLSFRO@dmu.ac.uk when your research project has been completed .

Yours sincerely,

Professor Judith Tanner Chair
Faculty of Health and Life Sciences Research Ethics Committee

Appendix XII. Inclusion and Exclusion criteria for participant inclusion in the research

Inclusion criteria

The inclusion criteria for participants was set as follows:
Designated PMLD – clinically and educationally assessed as profoundly developmentally delayed, believed to be operating intellectually within 0- 24 months.
With complex health needs -Having a wide range of physical, sensory and medical impairments that inhibit gross and fine motor movements, obstructing access to alternative means of non-verbal communication
(Gestures, Body Language, Signs, Objects of Reference, Alternative and Augmentative (AAC) devices.)
Professionally assessed as pre-verbal, showing no evidence of linguistic competence.
Without significant hearing impairment: no evidence of diminished acuity to sounds normally heard. Elzouki (2012).
Living and educated within an English speaking environment.
Under 25 years of age
NB: All participants had English as a first language, irrespective of ethnicity, a requirement due to the potential difficulty for the researcher in transcribing other languages.

Exclusion criteria

The exclusion criteria was set as follows:
Educationally assessed at developmental levels beyond Performance Level 4
Without physical or sensory impairments
Using communication strategies aligned with language and/or verbal speech
Without English as a first language
Hearing impaired
More than 25 years old
Data encompassing the participants' background and life experience was provided by parents, advocates, carers and staff in the homes and educational establishments of the participants. This data was collected throughout the period of the investigation.

Appendix XIII Participant details including date of birth, gender, learning disability and medical diagnoses contributing to the designation of PMLD.

Participant	D.O.B.	Gender	Learning disability	Medical diagnoses
1	28.08.95	M	PMLD	Severe DD, CP, Microcephaly, VI, Quad.
2	26.01.06	M	PMLD	Chromosomal abnormality, VI, Severe GDD, Quad.
3	15.05.98	F	PMLD	Cerebral Palsy, Epilepsy, VI. GD. Quad.
4	25.06.10	M	PMLD	GDD, CVI
5	02.08.10	F	PMLD	GDD, Epilepsy,
6	03.09.14	M	PMLD	CP, epilepsy, sensory processing dis- order. GDD.VI. Quad
7	31.01.05	F	PMLD	CP, VI, Epilepsy, Quad.
8	28.02.02	M	PMLD	Severe Microcephaly, Quadriplegic, Epilepsy VI, Severe GDD, Quad.
9	10.10.05	F	PMLD	Lissencephaly, Epilepsy, Nystagmus, Hypotonia. GDD, Quad.
10	11.09.06	F	PMLD	Severe CVI, Spinal Scoliosis, Epi-lepsy GDD. Quad.
11	03.09.07	F	PMLD	Recessive Gene Disorder, hypertonia, VI, delayed oro-motor skills.
12	16.07.05	M	PMLD	Microcephaly, Athetoid C.P. ASD. VI
13	10.02.04	M	PMLD	Hypoxix ischaemic encephalopathy, spastic tetraplegia. G Tube. Quad.
14	21.06.00	M	PMLD	Chromosome 1 abnormality, Epilepsy, VI
15	06.01.15	M	PMLD	Chromosome abnormality, GDD.
16	17.03.98	F	PMLD	Microcephaly, epilepsy, GDD
17	31.01.05	M	PMLD	Cortical malformation, Epilepsy.
18	13.12.07	F	PMLD	Severe hypoxic ischemic encephalo- pathy, quad, VI,
19	05.05.12	F	PMLD	CP, hydrocephaly, epilepsy, VI, move-ment, spasm disorder. Quad.
20	23.11.06	M	PMLD	Epilepsy, Haemophilia, neurodegen- erative disease. Quad.

Key to abbreviations used in Table 4.1..

PMLD Profound and multiple learning disabilities
VI Visual impairment

CVI Cortical visual impairment GDD
Global developmental delay SDD
Severe developmental delay CP
Cerebral palsy
Quad Quadriplegia, no functional use of limbs or torso
ASD Autistic Spectrum Disorder

Appendix XIV: Microphone trials

Microphone trials for sub vocal utterances were carried out prior to formal recordings.
Find below the transcripts of the recordings for comparison between the different mics and to compare the varying quality of the same samples:
AKGc414 Take 1
Shotgun Take 1 Neumannnkm184 PA4060 Stick Lavalier

AKGc414 Take 1
The numbers are from the original recordings and not relevant on these transcripts.
R: 0.00.000 This is a boy 0.03.000
0.05.531 They have started 0.07.228 w 0.7.724 Come on, you can….do it
0.11.200 w
0.13.600 This is hard 0.16.000 w
0.18.834 Can't 0.21.211 w
R: 0.25.358 Please say 'These are boys'
0.25.358 Listen, say it, 0.28.000 w R: 0.41.000 The boy is here 0.43.584
0.44.433 Sorry.. but…. I… tried… to say… that
0.58.114 Voiced
R: The boys are here
1.00.000 I can't 1.03.463 v
R: 1.14.000 This is a girl 1.17.196 1.24.742Can you hear me? 1.28.000 v
1.28.219 Perhaps he's… listening to me1.32.238 w
1.33.086 I'll try speaking 1.35.613 w
R: 1.35.698 These are girls 1.38.767
1.38.886 They're thinking, I'll learn to do this 1.44.448 w
R: 2.02.342 The girls are here 2.05.211
2.07.553 They are much too fast Rosie 2.14.646 w.)
R: 2.14.600 This is a church 2.18.181
2.20.224 Can't do it 2.22.588 w
2.21.843 Can't 2.23.000 voiced – re-pitched at 77
R: 2.26.812 These are churches 2.29.796
2.30.462 Trying to learn 2.32.367 w 2.28.830 I won't do it
2.30.882 voiced
2.27.512 Leave it 2.38.462 Voiced
R: 2.42.605 The church is here 2.45.635
2.46.415 Let him hear the records from us 2.50.685
4.28.616 Better 4.32.000

PA4060 Stick 1 Take 3
These are spontaneous samples recorded on this mic. Each sample is the original recording, followed by an adapted version. Most of the samples have been cleaned by Waves to reduce the level of the ambient noise and (hopefully) clarify the whispers.
The numbers are from the original recordings and not relevant on the adapted track

0.15.000 Rose, speaking for you w 024.075
Rose speaking for you DX

Now at last, I'll speak DX

0.26.200 Is he here? (Lorenzo) w 0.31.000
Is he here? DX

0.39.326 Come and start w 0.41.260 Come and start
DX , slowed

0.49.109 Now at last, I'll speak w 0.56.000

0.56.000 Now it's silent, I'll comment w 1.01.170
Now it's silent, I'll comment DX , Speech focus

1.12.482 All this time, I have waited 1.19.433
All the time, I have waited DX

1.55.470 It's better 1.56.649 w
It's better DX

DPA4060 FACE Take 2 Lavalier mic on participant's face.
These are samples of spontaneous whispers recorded on this mic. Each sample is the original recording, followed by an adapted version. Most of the samples have been cleaned by Waves to reduce the level of the ambient noise and (hopefully) clarify the SV utterances.
The numbers are from the original recordings and not relevant on the adapted track.
The first samples are reasonable but the later part of the recording becomes very 'fuzzy and hard to clean.

0.18.570 This time, relax 0.22.000 w
This time, relax DX

0.22.000 Yes, we've done 0.24.915 w Yes we've done
DX Slowed

0.38.229 I'm doing it 0.39.297 w
I'm doing it DX speech

0.55.500 They're bound …to visit.. my bedroom. W 1.00.530
Unchanged

1.05.600 Next time, I will think about all this 1.07.932 w
Next time, I will think about all this DX Speech focus Slowed

The samples now become increasing ‘fuzzy’ as follows. They can be cleaned with Waves but, after the initial good quality, something changes and the quality deteriorates as shown by the following samples.

Please Rosie, let’s end w
Please Rosie, let’s end DX Speech focus

6.45 640 We’ve had those. I can’t speak 6.52.747 w
We’ve had those. I can’t speak Direct X

DPA4060 SHIRT Take 2
These are samples of spontaneous whispers recorded on this mic. Each sample is the original recording, followed by an adapted version. Most of the samples have been cleaned by Waves to reduce the level of the ambient noise and (hopefully) clarify the whispers.
The numbers are from the original recordings and not relevant on the adapted track.

0.37.180 Speaking for you w 0.40.275 Speaking for you DX

0.47.755 I need to get faster w 0.50.308 I need to get faster D X

0.53.072 The speech was wrong w 0.56.887

The speech was wrong DX
2.51.869 We need to do it better 2.56.000
We need to do it better DX

3.34.428 Time to speak 3.39.000
Time to speak DX

A set of samples from different microphones. The microphones are: AKGc414 Take 1
Shotgun Take 1 Neumannnkm184 Blue Yeti
Using the identical track facilitate comparison of the quality between different mics where the same sounds are occurring.
Tests included samples from:
DPA4060 FACE Take 2 – used as a face mic PA4060 Stick 1 Take 3 – The gun mic

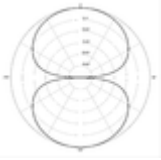
DPA4060 Shirt Take 2 – The mic attached to J's shirt. Blue Yeti - Take 2 on stand
Some of these samples have been adjusted in order to make them more audible or comprehensible. Where this occurs, it is marked on the transcript. The original sample before adaptation is also included to identify the original sound and the 'improved' sound.
The variable quality of the recordings may be a consequence of: Variable effectiveness of the mic in capturing J's whispers.
Position of the mic, bearing in mind that, wherever the mic is placed, J moves constantly therefore altering the feed-in to the mic
Variable quality of J's own voice. Some samples are better because the quality of his voice is better. There are obvious disadvantages for recording when J's voice is 'creaky' , very low or very 'breathy.'
All whispered samples suffer from the addition of ambient noise on the recording, often making the sound very 'fuzzy.' Some can be improved significantly (with Waves Direct X).
A mic is just a transducer. It reproduces what is already there by picking up vibration movement in the air and converting it into signal level AC electricity that flows down a cable and into the input of an amplification system. Using a range of mics should identify which is best for the different ways in which we intend to use it. Different mics are better or worse for different applications so choice of mic should depend on the purpose for which it is needed.
Generally, where vocal mics are being used, advice is to position the mic with 18" of the speaker to get the best result.
Depending on what is to be recorded, one pickup pattern may work better than another. The directionality of the mic is called the polar pattern and this determines how sensitive the mic is to sounds approaching from different angles.
Microphone Polar pattern

(Microphone facing top of page in dia- gram, parallel to page):

Bi-directional or Figure of 8

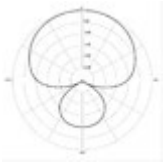
Sub cardioi

Omnidirectional

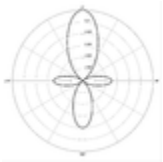


Cardioid

Hyper-cardioid



Super-cardioid



Shotgun

We will be using:
C 414 B/ULS
Large Diaphragm Condenser Microphone Yeti Tri-capsule condenser
This might commonly be referred to as a ‘studio’ mic, which will be plugged into the Traveller.
It has a range of pickup patterns and can be easily switched from one to the other. The four different pattern settings are:
Omnidirectional – non-directional in that the directionality of its response is like a perfect three dimensional sphere. The mics with the smallest diameter are the best omnidirectional and tend to record ‘pure’ sound, that is as near to the original sound as possible.
Cardioid This is a unidirectional mic that works particularly well for vocal recording as it captures speech from the front while reducing any pickup of noise from the sides and rear
Hyper cardioid -Super or hyper-cardioids provide a highly directional mic. This is known to be very effective at avoiding or limiting feedback i.e. when the mic is too close to the speakers and causes ‘screeching’ from the loudspeakers. It is also very effective at limiting spill or interference from other sound sources in the environment that are not wanted in the recording. It is believed to be very effective for indoor dialogue where early reflections may be present.
Figure eight. - The mics (often called Bi-directional use a pattern of two lobes that collects sounds equally from front and back (or left and right)
Using this mic gives us a choice of which ‘field’ of sound we are trying to capture and the opportunity to change between fields to test out which does best. One pickup pattern may prove to be more effective and, as four pickup patterns are available on one mic, we can use just one mic instead of requiring multiple mics.
The makers claim that it is one of the most accurate multi-pattern mics available.
-2 lavalier condenser microphones DPA 4060bm –
These are omnidirectional mics often used for theatre especially to provide good pickup for the human voice. They are specially designed to be mounted on the human body and often worn as lapel of tie clip mics. The omni-directional polar pattern effectively captures sound close to the capsule so that it prioritises the voice rather than other extraneous sounds. They are designed to cope with sweat, humidity, wind and ‘popping’ that can occur with the human voice,

using a vertical diaphragm as a ‘shield. Water resistant materials inside the mic protect it against moisture that might occur from sweat, saliva etc. They are also commonly used for interviews or monologues when the emphasis is merely on good quality recording of the human voice.

They also have two different protection grids to adjust amplification so that the mic can be acoustically modified to suit where it is placed on the body A short grid supplies a 3dB soft boost at 8 – 20kHz and is intended for use near or on the speaker’s head. The long grid gives a 10dB boost at 12kHz if the mic is worn lower down the body – the chest for example

Mounting the Lavalier mic can be problematic as it might capture and amplify the rustle of clothes or the speaker’s movements when mounted on the body. They are sometimes placed in the hair where interference from sound will be minimal or, if placed near clothes, the sound of rustle etc. will be dampened by wrapping it in sponge or another soft material. They can also be attached by a head wire to loop around the head and over the ears.
This mic will enable close recording of J’s voice. They are intended to be very accurate, using the omnidirectional pattern to capture the voice rather than other sounds in the environment. The grid adjustment for head or chest will enable us to experiment with the best placing, not only to capture the best sound but also in order to cope with J’s own continual movements and inability to tolerate mics generally. These mics are supposedly good at reducing proximity effect which occurs when the speaker is too close to the mic and increases the bass sound to create ‘booming.’ Booming might occur with J because we need the mic close to his mouth to capture the virtually inaudible whispers. The potential to place the mic at different points on J’s body such as the head, chest, hair etc., is also a useful characteristic as we need a mic close to his mouth but one that will not be reached and handled by J or that will not capture the sounds of clothes, movement etc.
-1 pencil condenser microphone AKG C451b
This is a cardioid condenser mic. It has a cardioid polar pattern which is directional and can therefore limit off axis (side section) leakage from the mic. Remaining on axis eliminates distortion to produce a clear, sharp and accurate recording. This should enable us to get as much sound from J onto the mic and thus onto the recordings.
It has a light diaphragm to minimalize handling noise and can be switched to eliminate low-end rumble. This will be beneficial as we may need to handle and move the mic while taking samples.
Condenser mics usually provide good high frequency response and sibilance and therefore good clarity. However, pencil mics can result in low frequency woofing or popping noise when used in proximity to breathing as the breath pressure overloads the diaphragm in the mic. Some pencil mics have a ‘golf ball’ in front of the speaker’s mouth, so that the effects of the breath pressure of the speaker is separated from the mic capsule.
Rhodes shotgun microphone – highly directional, tubular mic.

Shotgun mics are highly directional. They pick up some sound to the sides and rear but significantly less than other mics. Thus, this is another super cardioid polar
pattern mic, particularly suited to minimising noise at the off-axis (sides) of the microphone. The directional quality of the mic uses a very sensitive and narrow pick up pattern at the front to record the sound source and reproduce an accurate recording. Even in a noisy environment, this should ensure greater intelligibility. This is really important with J as part of the requirement is to ensure intelligibility as well as quality of recording. In addition, the narrow focus of the direction may be particularly good for capturing J’s whispers if used sufficiently close to the mouth. This mic is also intended to limit handling noise or interference by loose cabling etc
These can be problematic indoors as they can create booming as they cancel off axis sound. They are commonly used for outdoor recording. However, they may be good at recording room tone (the ambient sound of the room.) They are also often used in conjunction with digital video. It is intended to exhibit low noise while reducing low frequency rumble.

Noise cancelling mics are highly directional but have two diaphragms in opposite electrical polarity. One is placed as near to the sound source as possible, with the other further back in the mic, and this will capture unwanted sounds that will be subtracted from the signal arriving at the front diaphragm. These results in a combination of sounds but those not near the intended source are significantly limited. This has real advantages for intelligibility.
Dynamic range is the measure of the how well the mic responds to loud sounds.
Frequency response is how smoothly they reproduce the amplitude of the notes that are fed into them. Frequency response varies in different mics but is what provides its characteristic sound.
Mics can produce rumbling noises in the speakers due to handling. The use of mic stands should eliminate this as long as there is no vibration from other sources such as the floor or nearby furniture. Yeti mounts capsules on rubber

grommets to eliminate noise.

Analysis of acoustic data – chain as below:

Recording
Choice of the recording equipment (interface, software, microphones)
Choice of the microphones positioning
Carry out recordings

Amplify

Filtering and processing
Editing
Analysis
Test
Ask a group of subjects to "rank" in terms of intelligibility the different processing and recording techniques

My samples AKGc414_Take1 adapted (2) Amp x 3 10dB
Ambient noise Speech focus
025.348. Voiced : Faded 10dB x 2 before and after 'I' then silence inserted between I can't. (2 secs silence) and 'It's a little bit more of a worry.' 0.34.855 Pitch altered to
145 THIS IS AT 0.31.000 – 0.34.738 ON ORIGINAL AKGc414_Take1 adapted (2)

Transcripts
This is the transcript for all of the following so that we can compare the varying quality of the same samples:
AKGc414 Take 1
Shotgun Take 1 Neumannnkm184
The numbers are from the original recordings and not relevant on these transcripts. PA4060 Stick 1 Take 3
Spontaneous
These are samples of spontaneous utterances recorded on this mic. Each sample is the original recording, followed by an adapted version. Most of the samples have been cleaned by Waves to reduce the level of the ambient noise and (hopefully) clarify the whispers.
The numbers are from the original recordings and not relevant on the adapted track. w – whisper DX – Waves
0.15.000 Rose, speaking for you w 024.075 Rose speaking for you DX
0.26.200 Is he here? (w 0.31.000

Is he here? DX
0.39.326 Come and start w 0.41.260 Come and start DX , slowed
0.49.109 Now at last, I'll speak w 0.56.000 Now at last, I'll speak DX
0.56.000 Now it's silent, I'll comment w 1.01.170
Now it's silent, I'll comment DX , Speech focus

1.12.482 All this time, I have waited 1.19.433 All the time, I have waited DX

1.55.470 It's better 1.56.649 w
It's better DX

DPA4060 FACE Take 2 Lavalier mic.
These are samples of spontaneous whispers recorded on this mic. Each sample is the original recording, followed by an adapted version. Most of the samples have been cleaned by Waves to reduce the level of the ambient noise and (hopefully) clarify the whispers.

The numbers are from the original recordings and not relevant on the adapted track. w – whisper DX – Waves
The first samples are reasonable but the later part of the recording becomes very ‘fuzzy and hard to clean.

0.18.570 This time, relax 0.22.000 w
This time, relax DX
0.22.000 Yes, we’ve done 0.24.915 w Yes we’ve done DX Slowed
0.38.229 I’m doing it 0.39.297 w
I’m doing it DX speech focus
1.05.600 Next time, I will think about all this 1.07.932 w
Next time, I will think about all this DX Speech focus Slowed

The samples now become increasing ‘fuzzy’ as follows. They can be cleaned with Waves but, after the initial good quality, something changes and the quality deteriorates as shown by the following samples.
6.45 640 We’ve had those. 6.52.747 w We’ve had those. Direct X

DPA4060 Take 2
These are samples of spontaneous whispers recorded on this mic. Each sample is the original recording, followed by an adapted version. Most of the samples have been cleaned by Waves to reduce the level of the ambient noise and (hopefully) clarify the whispers.
The numbers are from the original recordings and not relevant on the adapted track.
0.37.180 Speaking for you w 0.40.275 Speaking for you DX
0.47.755 I need to get faster w 0.50.308 I need to get faster D X
0.53.072 The speech was wrong w 0.56.887 The speech was wrong DX
2.51.869 We need to do it better 2.56.000 We need to do it better DX
3.34.428 Time to speak 3.39.000
Time to speak DX
Using a chain of commands, the recorded data should be:
1. Empirical Recording Analysis Processing Testing
I think we need to establish:
A chain for one initially.
Using a single participant will provide samples that can be analysed and processed in order to develop a model process that may subsequently be tested against other participants. However, if we processed six sets of samples initially, I suspect that each would require different processing to establish intelligibility. It seems more appropriate to process one set of samples (of a significant number) and perhaps test the resultant
process against other individuals later as part of the ‘Test’ element of the research design.
In terms of the time frame, must establish:
How many samples
How long each sample should be
The precise content of the samples Transcript for Mic AKGc414 Take 1
It is necessary to take much longer – you can hear the breathing problems and he is obviously tiring as we go through – better to record samples on separate occasions. However, this occasion gives the opportunity to test the different mics.
Some of these samples are adapted – could compare with the originals
6.50. 556 This is a sample 6.55.189w Outcome of tests
Blue Yeti on cardioid setting on the original stand. Good quality sound card
Use in the upright position 10 cms from mouth
USB into computer, using computer unplugged so that it runs on batteries.

Appendix XV: Details of Sound Box

Using the Sound Box

The Sound Box plays back the child's own sub vocal or vocal speech so that they can hear it in real time.
It does not record.
It helps them to understand that they can speak, sub vocally
We are trying the Sound Box to see if using it will improve the quality of the child's sub vocal speech.
Some children really like to use it, even if it cannot improve their sub vocal voice With some children, you may be able to hear their sub vocal comments.
You can listen to them and also talk to them, via a second set of headphones.
To use the box:
Connect the headphones to the box by inserting the jack plugs into the colour matched sockets (for microphone and headphones)
Switch the Sound Box on by the switch in the centre. A red light will come on.
If the red light is not on, the batteries need replacing. David can do this.
Test the headphones on yourself. Make sure the volume is adjusted – as loud as possible but not too loud for the child. You should be able to hear your own soft whisper.
Switch the headphones off before putting them on the child. Left on, the open headphones produced an unpleasant, high pitched whine.
Put the headphones on with the mic at the front. Adjust headphones to size to fit snuggly over the ears.
Switch on.
Make sure the mic is close to the mouth and stays close to the mouth while in use. This is because any sub vocal utterance is normally inaudible and needs a lot of amplification.
The Sound Box is usually only in use for a short time – intervals of 1 minute if preferred by the child– and only if the child is enjoying the experience. Some children will happily use it for much longer.
If the child is not enjoying the experience, the Sound box should not be used.
For children wearing glasses, these should be removed so that the headphones do not press against them and cause discomfort.
The child should not pull at the headphones, microphone etc. The current equipment is fragile.
When the child has finished, switch off the box (to conserve the battery life) then remove the headphones. This will avoid any 'whine' while the headphones are open.
At the end of a session, make sure the Sound Box is switched off before packing it away in its case.
Please use the book to log every time the Sound Box is used:
Name, date, length of time for pupils using the Sound Box and sign for yourself.
This information will be used to monitor any progress or changes that could be the result of the child using the Sound Box.

Technical details of the Sound Box

There are two types of sound box used at the moment.

The complete box that has a microphone preamplifier, headphone amplifier with two headphone output sockets and a USB sound card to connect to a laptop computer.

A smaller sound box with a microphone preamplifier and a headphone amplifier for the speaker to use just to listen to themselves and practice speaking.

This gives a much higher signal level to the computer, thus not so much background noise is present. Most participants

really enjoy hearing their own speech.

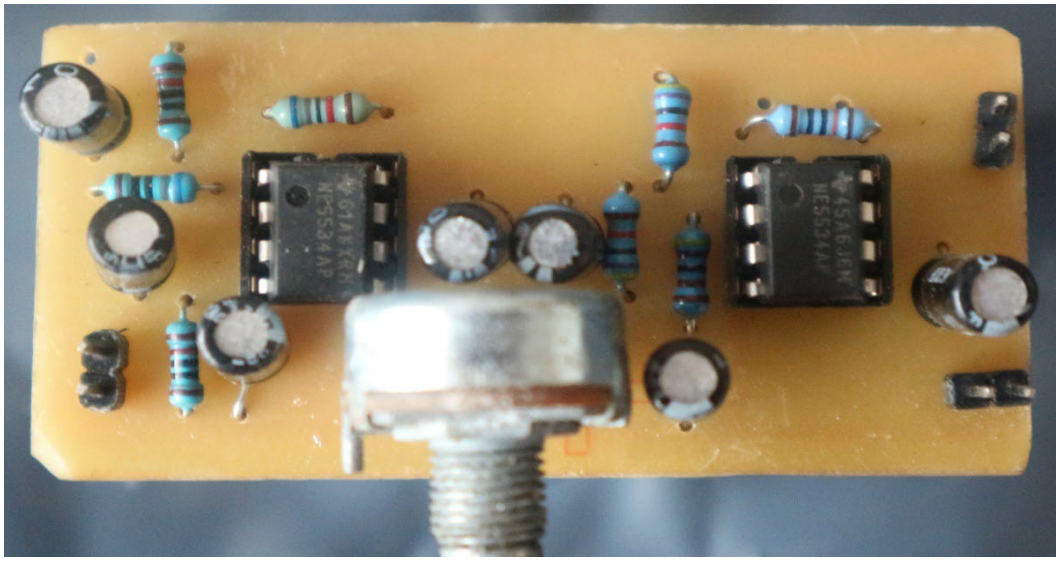
There could be acoustic feedback due to the closeness of headphones to microphone. Some speakers find it hard to tolerate badly fitted headphones.

At the moment experiments are being done with vocal speech filters to insert in the preamplifiers to cut out as much local background noise as possible.
A very small amplifier with miniature speakers is being trialled to let listeners hear speech without having to use headphones.

Figure 1 : The external and internal Sound Box.

Current Sound Box. Case is metal to screen from interference

Microphone preamplifier from inside box



Small soundcard mounted at rear

Appendix XVI: Spectral entropy

The following refers to collaborative outcomes of work with Loughborough University (Dr.David Kerr) now included in a collaborative paper ‘It’s good to talk’ in preparation Woods, Kerr and Cornelious. The signal processing was undertaken by Dr.David Kerr.

Spectral entropy is a measure of the statistical ‘disorder’ of the data. The assumption here is that a signal containing purposeful information would show a much higher amount of order, i.e. lower entropy than a random signal containing mainly noise.
A moving window of width N samples was used to compute the short-time Fourier Transform of the audio data, after applying a Hanning window to reduce spectral leakage. N was chosen to be an integer power of two. The power spectrum values pspec were then used to calculate the spectral entropy and the flatness of the signal. Note that adjacent windows were designed to overlap by 50%. The best values for N in terms of quality of results and computational efficiency appeared to be 4096. N=4096 samples represents a window width of 0.093 seconds, for a sample rate of
kHz.
Entropy was calculated by dividing each spectral amplitude in pspec by the sum of all the N amplitudes (to obtain normalised approximate probability P) and then using the measure defined in equation (1).

$$\text{Signal entropy} = -\sum_{i=}^{N} P_i \log_e P_i \qquad (1)$$

The Spectral Flatness was obtained from pspec according to equation (2).

$$\text{Spectral Flatness} = \frac{\left(\prod_{i=1}^{N} \text{pspec}(i)\right)^{\frac{1}{N}}}{\frac{1}{N}\sum_{i=1}^{N} \text{pspec}(i)} \qquad (2)$$

i.e. the shifted and scaled power spectrum geometric mean divided by its arithmetic mean. Figure (1) shows a typical signal plot, along with the entropy and flatness results.
Signal pre-processing and data selection

A range of recordings was analysed, consisting of normal speech from members of the study team, and sub vocal speech by the research participants, containing short pauses or periods of silence to act as a comparator. For each recording, graphs like those illustrated in figure 1 were obtained, with the total sample limited in time to short sections of speech or attempted speech, each lasting only two or three seconds.
Spectral entropy and flatness were measured separately for voice active sections, and for gaps or pauses. For each section examined, median values of each parameter are shown in Table (1) below.

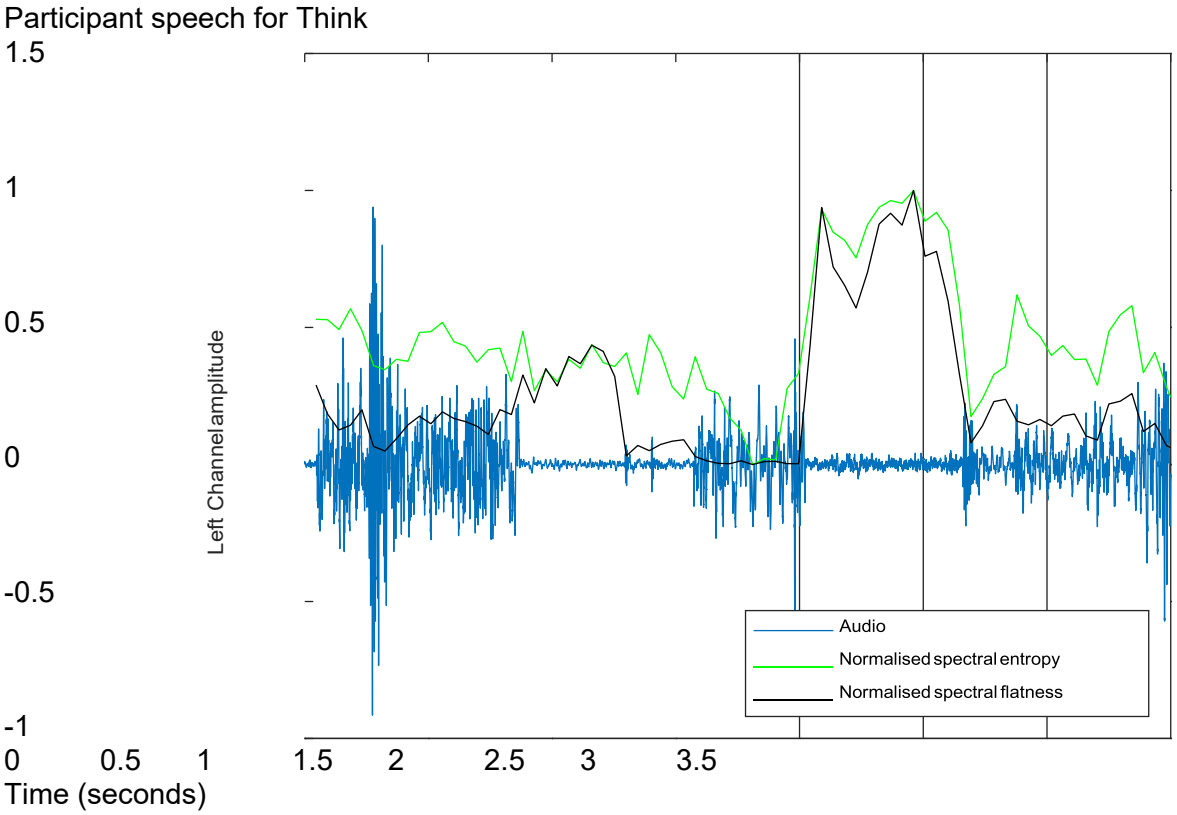


Figure (1) – Speech pattern from Participant voice 2, with spectral measurements shown alongside the audio signal for comparison

Appendix XV11: Pilot Test of Listener Intelligibility

Appendix Pilot test procedure

The procedure (identified in the Pilot test) was as follows:

Thank listeners and give a brief explanation of the study.
Seat listeners at equidistance from the laptop.
Ensure listeners have pens, are comfortably seated and can rest their forms on a hard surface.
Allocate listener numbers to maintain anonymity.
Ensure all participants have read the Listener Information forms.
Collect Consent Forms.
Check that Consent Forms are correctly completed.
Hand out Test Papers.
Explain the protocol for the test as follows:
Each Test is on a separate page.
Conduct tests
Once a test is completed, listeners must not return to that page (to avoid adjusting the original notation in response to later information contained in the test material.)

Listener Tests

A series of tests will be conducted during which listeners will be asked to judge and rate SV samples for intelligibility. Tests will be carried out in the speech laboratory of De Montfort University, using volunteer participants. Formal listener tests will be preceded by a pilot test to establish the best structure, format and procedures for the listener tests and to establish a body of information about the ability or otherwise of listeners to rate and make judgments about SV utterances.

The pilot test will use a small number of volunteer participants to represent both familiar and unfamiliar listeners to establish a body of information about the ability or otherwise of listeners to rate and make judgments about SV utterances. The pilot will trial the intended procedures for the authentic listener tests and identify potential difficulties in gathering relevant data accumulated from the tests. The selection of appropriate statistics for the presentation of relevant data is required and outcomes of the pilot test may contribute to the appropriate choice. In addition, it is anticipated that responses from the participants in the pilot test will identify the appropriate number of samples to be used and the best methods for presentation of the samples. Responses from listeners in the pilot test will provide a rationale for a more extensive data collection, using a cohort of listeners (20) to participate in a range of listener perception tests to rate or judge SV phonation.
Analysis of resulting listener data will also contribute information about the listener profile most suited to comprehension of SV phonation. Listener tests will contrast findings between familiar listeners, teaching staff and parents for example. Data provided by listeners may contribute to an understanding of an appropriate listener profile, which, when used in a communicative partnership
with SV speakers, could identify listener attributes best able to facilitate SV functional communication.

All samples, both spoken and sub vocal will be presented as digitally recorded samples as the impairments and disabilities of the participants prelude any realistic expectation of attendance during test procedures.

Speech and Language Therapy students at De Montfort University will be invited to participate in the pilot. Although the pilot is largely concerned with establishing the most suitable procedures and methodology, results may also suggest whether the lack of prior experience is a significant handicap in understanding SV utterances.
Participants will be required to rate or judge samples of SV utterances in order to identify which approximate most closely to normal speech. Participants will be asked
'Which samples sound more like normal speech?'

The samples will incorporate elements that are additional to acoustic speech sounds, such as prosody, duration and

rate of speech and instrumental analysis will be used to ascertain if the samples fall within normal limits.
The samples will be:

spoken and undervoiced utterances

Spontaneous (accompanied by an explanation for using spontaneous

samples, including reference to the inability of the research subject/s to produce controlled output. Mention should be made of this fact as relevant for ethical considerations as well as for the impact on data.)
matched for length as far as possible

matched for amplitude (using 60 dB as the normal standard for amplitude of the human conversational voice)
To process samples, the following will be undertaken:

Recording the initial dB level of each sample and the subsequent level after amplification. This is to show the extent to which individual samples have been amplified.
Reducing dB levels of voiced samples back to 40dB where necessary

Recording any additional ‘cleaning’ of individual samples and the reason/s for so doing, such as extraneous noise or ambient noise.
Outlining all the things that affect the quality of the SV sound.

Each test uses 6 samples. Two forms of presentation will be trialled as follows:

The first will enable listeners to repeat/replay samples as often as required

The second will repeat each sample three times only.

Currently, the understanding is that

a ‘raw’ whispered sample will be defined (and explained) as a sample that has been amplified sufficiently to be heard and had ambient noise removed (but only up to the point at which the sample becomes audible to the listener.) The pilot test may have implications for this conclusion.
The pilot test will include an information sheet detailing what the participants are required to do.
The test will be followed by a questionnaire and/or an interview to ascertain opinions about the test procedure such as:
How should the acoustic stimuli be best presented to enable participants to make valid judgements? (The test uses two different forms of presentation of the samples)
What are the advantages and disadvantages of different forms of presentation of the stimuli?
•What number of examples/samples would be most effective in enabling participants to make judgements? (The test offers continuous playback or limited playback of each sample repeated 3 times)
Did participants try to understand the content of the samples (Efforts to do so might detract from the ability to judge the samples effectively.)
NB: Sample presentations during pilot tests and real tests may be constrained by the nature of the technology in the Speech Laboratories and the need to ensure replication of presentation for listener tests in schools and homes of PMLD participants

Listener information form

A Study in Developing a Vocal Communication System Ref: 1163

You are invited to volunteer to listen to recordings of speech or whispers in order to judge if you can understand them. This research is part of PhD study at De Montfort University into distorted and disordered speech. It looks at ways to use computer programmes to adjust digitally recorded samples of sub vocal phonation
You will be asked to listen to recordings of spoken or sub vocal speech samples to assess intelligibility.
The samples are produced by individuals who have problems producing speech but produce sub vocal phonation.
The sub vocal samples do not sound like whispers or speech.
The samples are initially inaudible
The samples may be of poor quality because recordings include ambient noise and non-speech sound such as swallowing or gulping, as well as SV speech.
Samples have been digitally recorded, amplified and cleaned to remove (as much as possible) noise that may obstruct SV sound signals. The process for removing ambient and extraneous noise (that is not part of the SV phonation) from samples is described subsequently.
You do not need any special skills or experience, only the ability to hear adequately and to fill in a simple form.
You may benefit in gaining some knowledge and experience of dysarthric speech and sub vocal phonation. You may also contribute to research to increase the intelligibility of dysarthric speech and sub vocal phonation. You may also provide information which will inform debate or can be used to seek funding for more research.
If you would like to learn more about this research or more information about participating, please contact
R.Woods
Email woodsrh@btinternet.com.

Pilot Test Questionnaire

Questionnaire/interview

The test offers continuous playback or limited playback of each sample repeated 3 times

How should the acoustic stimuli be best presented to enable participants to make valid judgements?
Playback
Continuous playback
Playback x 3

Identifying the target word - Single Word tasks. What mode of presentation was best?
Closed single word Marking the target word from a given selection
Open single word Identifying the word within a given semantic class e.g Colours

What are the best forms of presentation of the samples?

Sentences with context Normally voiced questions with sub vocal responses Sentences without context Open sub vocal phrases with no context.

What number of samples would be most effective in enabling participants to make judgements?
5 – 10
10 – 20
20 - 30
Samples can be presented with a pause in between each repetition. How long a pause would be best?

second
seconds
seconds
seconds
seconds

Did you find the presentation of samples best if:
All listeners are grouped together to hear centrally controlled samples
Listeners are invited individually (one at a time) to hear samples.

Was it better to:
To replay samples continuously, as often as required
To repeat each sample three times only.
Notes on outcomes of pilot listener test
The test sought to optimise listener perception by piloting different modes of presentation of samples so that outcomes could contribute to the format of the formal listener tests
The pilot presented the samples for listener trials because PMLD sub vocal phonation is atypical and beyond the experience of the majority of normal listeners. Listener perception is, as yet, unknown.
If positive outcomes could be shown to accrue for one or the other of the above, some understanding of strategies to enhance listener perception of SV phonation could result. The practical application of SV phonation as a communication system may benefit from insights into the efficiency with listeners can identify meaning in utterances.
Variations in presentation were piloted in order to identify the procedure that best facilitates listener comprehension.
While individual listening allows for variations in presentation, group listening is faster and therefore more efficient but

may exclude results from listeners requiring slower presentation of samp

Appendix XVIII : Data on Listener tests 1-9

All tests 1-9

Test 1a

Test 1a: Target word: Speak

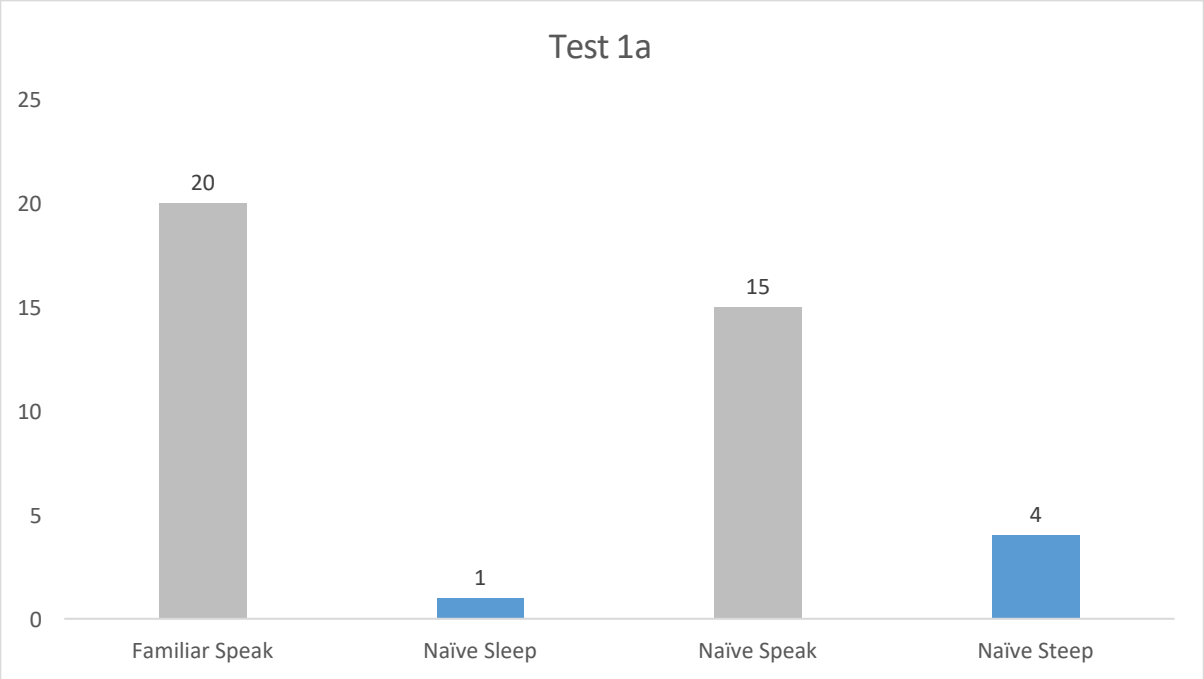
Test 1a was designed to provide data on the ability of listeners to discern fine phonetic differences.
Test 1a required listeners to identify 1 target word (Speak) from a closed selection of 6 options

Speak	x
Seek	
Squeak	
Steep	
Streak	
Sleep	

Results for Test 1a

35 listeners correctly identified the target word, 20 familiar and 15 naïve The utterance was intelligible to 87.5% of listeners.
The error pattern on the graph below shows that ‘Sleep’ and ‘Steep’ were incorrectly identified by naïve listeners, with no errors for familiar listeners. Familiarity facilitated identification of the target, indicating that familiar listeners were more able than naïve listeners to extract sufficient phonetic information to make a decision about what they had heard. However, as this was the first word in the test, the lack of experience for naïve listeners may have been particularly significant.
The ability of listeners to perceive fine phonetic differences.

The results identified the ability of listeners to discern the fine phonetic difference between the word Speak and the other very similar options. Familiar listener were better able to do so, than naïve listeners, but a significant number of naïve listeners also did so



Test 1b

Target word ‘Dad’

This test was designed to provide data on listener perception of one syllable, phonetically dissimilar words.

Test 1b required listeners to identify 1 target word from a closed selection of 6 options.

Box	
Toe	
Dad	x
Pat	
Lip	

Cot	

Results for Test 1b

As seen on the graph below:

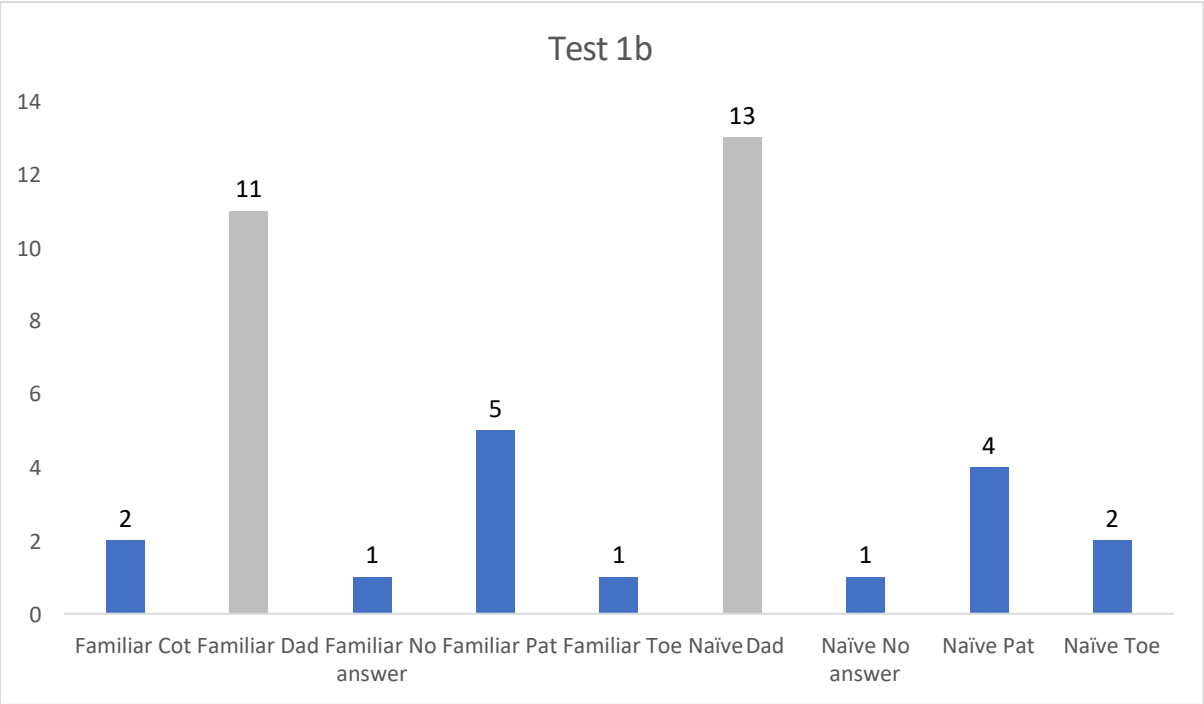
24 (60%) listeners correctly identified the target word.

The target word was intelligible to 60% of listeners. Of these, 11 were familiar and 13 naïve.
16 listeners failed to identify the target word.

Naïve listeners performed better than familiar listeners on this test. 13 naïve listeners were correct, in comparison to 11 familiar listeners who were incorrect. The error pattern also displays less errors/No Answer for naive listeners (7) in comparison to familiar listeners with 9 errors/No Answer

The error pattern shows that 9 listeners (4 naïve and 5 familiar) incorrectly identified ‘Pat’, while ‘Cot’ and ‘Toe’ were also mistakenly selected but by small number of listeners (6), naïve and familiar.
The ability of listeners to correctly perceive one syllable, phonetically dissimilar words.

The percentage correct is 60%, showing that the majority of listeners could perceive one syllable, phonetically different words. However, the scattered error pattern show that the number of listeners who incorrectly selected ‘Pat,’ ‘Toe,’ and ‘Cot’ or No Answer, found the phonetic information in a one syllable SV word to be perceptually limited.



Test 1c

Test 1c required listeners to identify 1 target word from a selection of 6 bi- syllabic words with a similar ending ‘ing.’ This test was designed to provide data on listener perception of bi- syllabic, phonetically dissimilar words, with a dissimilar first syllable and an identical second syllable.

Running	
Nothing	
Talking	
Something	x
Living	
Making	

Results for Test 1c

As seen on the graph below:

34 listeners correctly identified the target word.

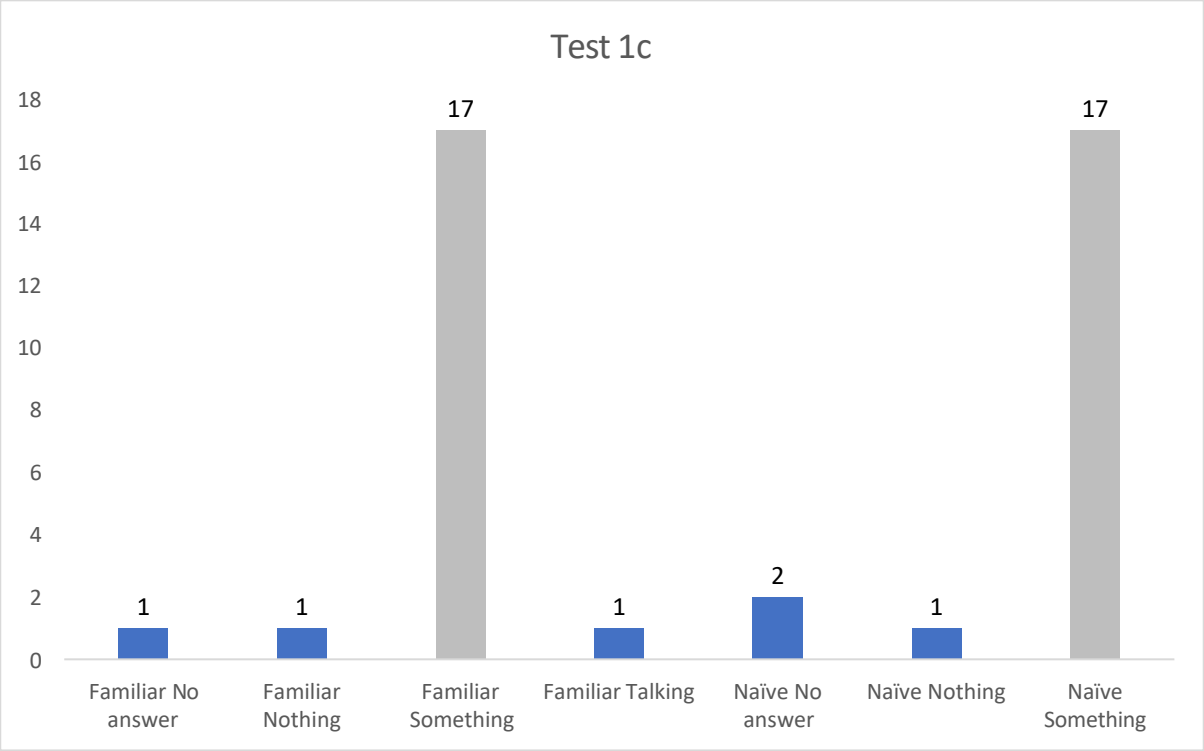
The target word was intelligible to 85% of listeners.

Of these, 17 were familiar and 17 naïve

6 listeners failed to identify the target word. Of these, 3 were familiar, and 3 naïve.

Of these, 1 familiar listener recorded No Answer, and two naïve listeners recorded No Answer
The error pattern displayed limited errors, with ‘Nothing,’ selected by only 2 listeners (1 naïve and I familiar) and 2 ’No Answer,’ by 1 naïve and 1 familiar listener. 1 familiar listener incorrectly identified ‘Talking.’

The ability of listeners to perceive bi-syllabic, phonetically dissimilar words, with a dissimilar first syllable and an identical second syllable.
The ability of listeners to correctly perceive the bi-syllabic target was demonstrated by 85% of listeners, who clearly perceived the differing first syllable. Perceptually, listeners needed only to identify the first syllable of the target word, as the second syllables were consistent for the other options. That 34 listeners did so, with an equal balance of naïve and familiar, suggests that the influence of the first syllable may have been significant. An interesting extension of this test would be the presentation of 6 words, all with a consistent first syllable and varied second syllables



Test 1d

Test 1d Target word: Perfect

Test 1d required listeners to identify 1 target word from a selection of 6

This test was designed to provide data on listener perception of bi- syllable, phonetically dissimilar words. Unlike Test 1c, both syllables were dissimilar.

Special	
Awkward	

Every	
Rabbit	
Bedtime	
Perfect	x

Results for Test 1d.

As seen on the graph below:

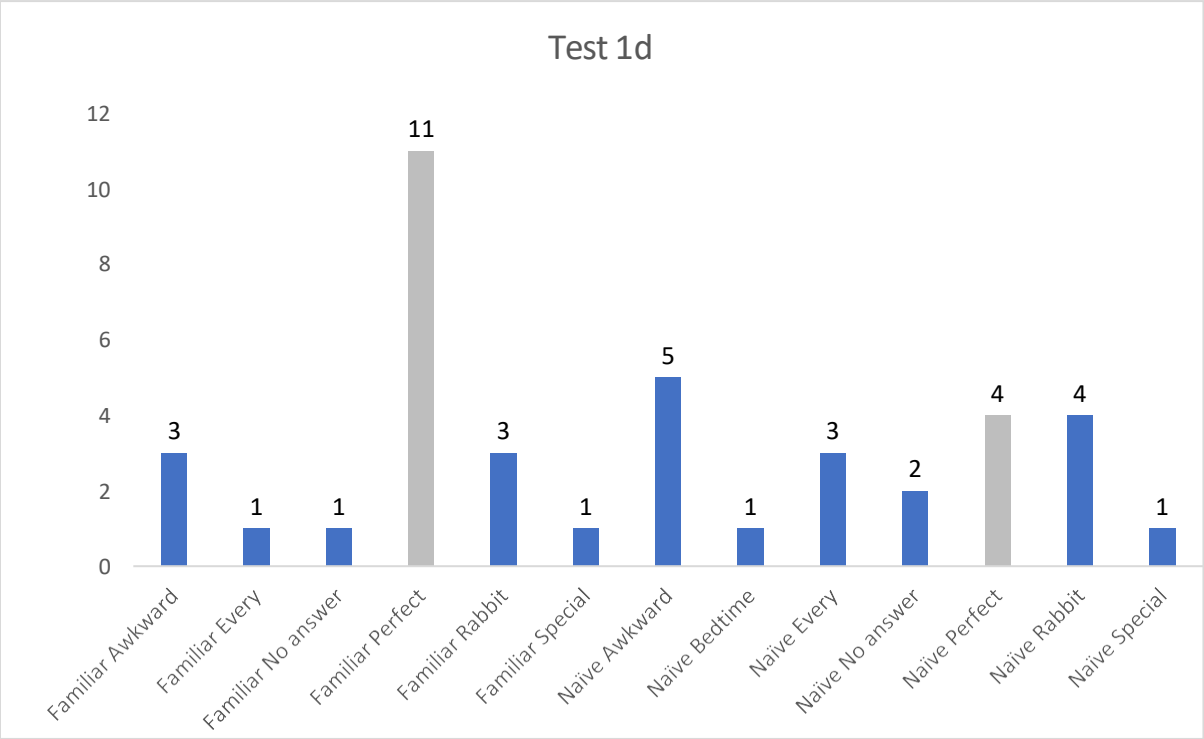
15 listeners correctly identified the target word, with a significantly larger number of listeners (25) failing to record a correct response.
The target word was intelligible to only 37.5% of listeners.

Familiarity appeared to have a positive bias in this test, with more familiar listeners

identifying the target, than naïve listeners (4). Familiar listeners had fewer errors (9), in comparison with 16 errors by naïve listeners.
The error pattern is wide, across both familiar and naïve listeners, with significantly more incorrect (25) than correct (15) answers. All words in the grid were selected by listeners, suggesting that this target word particularly challenged perception.
Unlike Test 1c, both syllables were dissimilar.

The presentation of 6 bi-syllabic options, all noticeably dissimilar, may have required more perceptual focus than had been required in previous tests. Listeners clearly

scanned across all options, creating an error pattern that included every option available.
The target word ‘Perfect’ achieved the second lowest score across all words in Tests 1a – 1e, suggesting that listener perception was challenged by the increased variations in the phonetic structure of the options.



Test 1e

Target word: Lucky

This test was designed to provide data on listener perception of bi-syllabic phonetically dissimilar words, with a one syllable word (Late) as a foil to Lucky, both words having the same initial sound.

Often	
Lucky	x
Late	
Today	
Saving	
Mostly	

Results for Test 1e

As seen on the graph below:

14 listeners correctly identified the target word Lucky,.

The target word was intelligible to only 35% of listeners.

26 listeners were incorrect, significantly more than the number of listeners who were correct.
Naïve listeners out performed familiar listeners in this test, but the margin is small. 6 familiar and 8 naïve listeners were correct and fewer naïve listeners were incorrect
, in comparison to familiar listeners (1)

Listener perception of bi- syllabic, phonetically dissimilar words.

Test 1e proved to be similarly challenging to listener perception, as had Test 1d and there are similarities in the outcomes.
The presentation of 6 bi-syllabic options, all noticeably dissimilar, may have required more perceptual focus than had been required in previous tests. Listeners clearly scanned across all options, creating an error pattern that included every option available.
The error pattern included 26 incorrect answers/no answers, including all potential options. All words in the grid were selected by listeners, suggesting that this target word particularly challenged perception. The high number (8) of 'No answer' responses also indicate the difficulty had by listeners in correctly perceiving the target, in comparison to the other options available.
The foil 'Late' was selected by 10 listeners (6 familiar, 4 naïve) suggesting that listeners did identify the initial sound of the target word and ignored or failed to perceive the lack of a second syllable necessary for the word 'Lucky.'
The target word 'Lucky achieved the lowest score across all tests 1a – 1e.'

The low scores on both Test 1d and 1e suggest that bi-syllabic, phonetically dissimilar SV words are hard to distinguish for both naïve and familiar listeners.

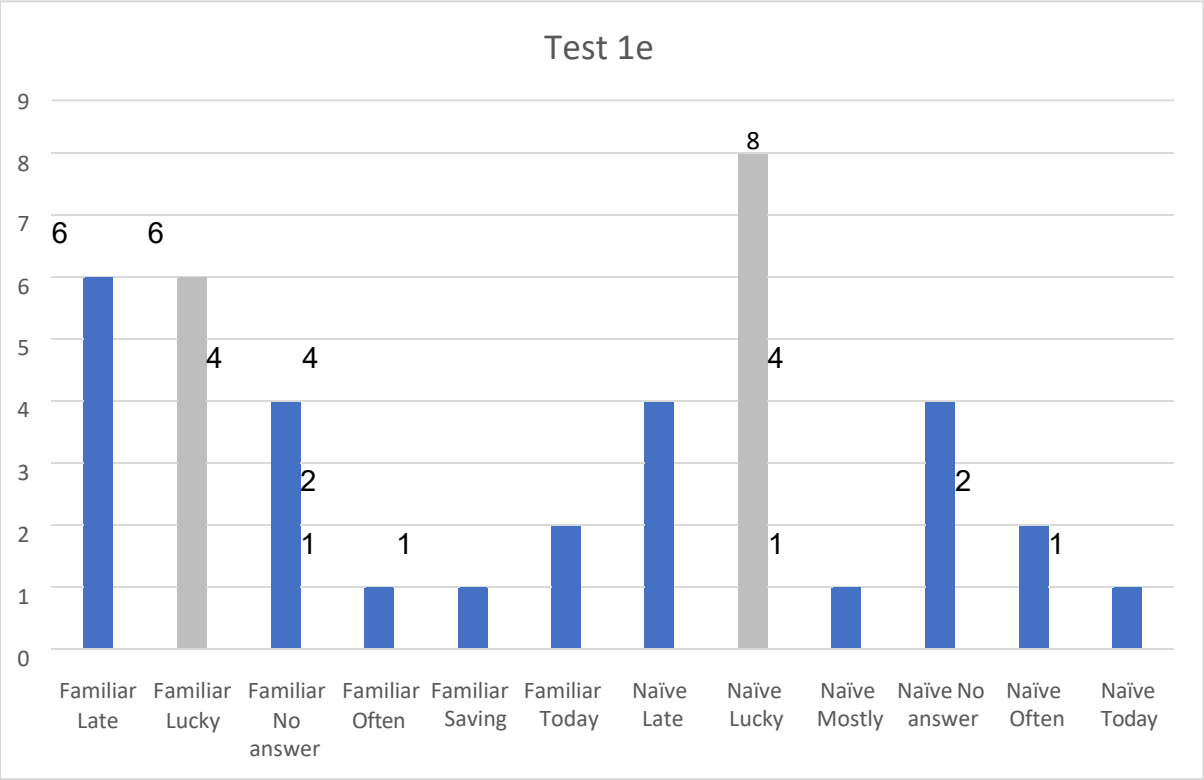


Table A below identifies for all closed tests:

Scores per word
Percentage per word
Total score overall
Total percentage overall

Table A

Test 1 - Correctly Scored from 40			
	Word	Score	Percentage
Test 1a	Speak	35	87.5
Test 1b	Dad	24	60
Test 1c	Something	34	85

Test 1d	Perfect	15	37.5
Test 1e	Lucky	14	35
	Total	122	
	Max	200	61

Table B identifies outcomes for all 40 listeners for Test 1 a,b,c,d,e. Listeners are identified by numbers and as naïve or familiar.
Overall scores per listener
Overall percentage per listener

Table B

Test One Results				
Listener Number	Familiar Naïve	Correct Words	out of	Percentage
1	Familiar	3	5	60
2	Naïve	4	5	80
3	Naïve	4	5	80
4	Familiar	3	5	60
5	Naïve	4	5	80
6	Familiar	3	5	60
7	Naïve	4	5	80

8	Naïve	2	5	40
9	Naïve	3	5	60
10	Naïve	2	5	40
11	Naïve	3	5	60
12	Familiar	4	5	80
13	Familiar	4	5	80
14	Naïve	3	5	60
15	Naïve	4	5	80
16	Familiar	2	5	40
17	Naïve	2	5	40
18	Naïve	3	5	60
19	Familiar	4	5	80
20	Familiar	5	5	100
21	Naïve	1	5	20
22	Familiar	3	5	60
23	Naïve	4	5	80
24	Familiar	4	5	80
25	Naïve	3	5	60
26	Naïve	3	5	60
27	Familiar	3	5	60
28	Naïve	2	5	40
29	Familiar	2	5	40
30	Familiar	4	5	80
31	Naïve	3	5	60

32	Naïve	1	5	20
33	Familiar	4	5	80
34	Familiar	3	5	60
35	Familiar	4	5	80
36	Familiar	2	5	40
37	Familiar	1	5	20
38	Naïve	2	5	40
39	Familiar	3	5	60
40	Familiar	4	5	80

T Test results for familiar and naïve for Test 1 were p = 0.233413

Test 2

Test 2 was designed to provide data on listener perception of CVC words and thus the influence of consonants and vowels (CVC words) on the intelligibility of sub vocal phonation.
Listeners were required to hear each of the words in the grid, in random order, writing down each word as heard.
40 listeners heard 5 words to equal 200 words

Test 2

You will hear six words, one at a time, from the list of words below. Please write each word in the grid below as you hear it.
If you do not recognise a word, please leave the box blank. Some words might be repeated.
YES MUM BUS SIT DAD

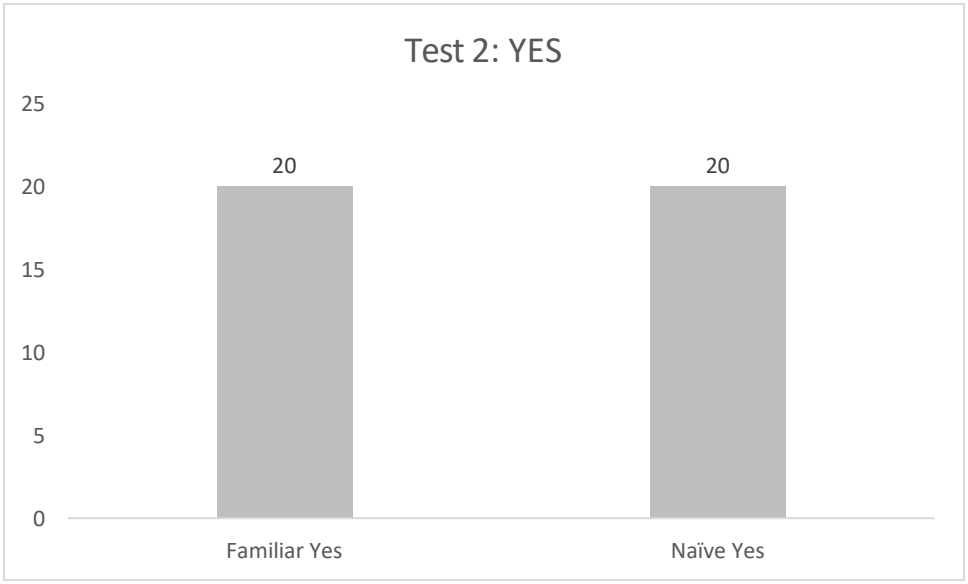
The words are inserted correctly in the grid below

SAMPLE 1	YES
SAMPLE 2	BUS
SAMPLE 3	DAD
SAMPLE 4	MUM

SAMPLE 5	SIT

Test 2 a

Target word Yes



Results for Test 2a - Yes

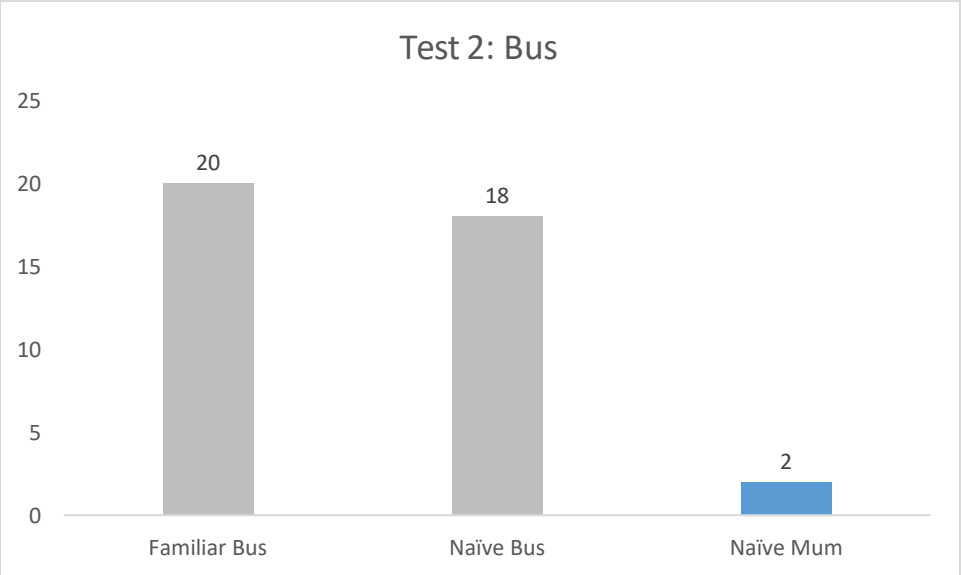
Target word: Yes

40 listeners correctly identified the target word Yes. The target word was intelligible to 100% of listeners
20 familiar listeners and 20 naïve listeners correctly identified Yes as the target word.

There was no discernible difference between naïve and familiar listeners and no error pattern.

Test 2b

Target word Bus

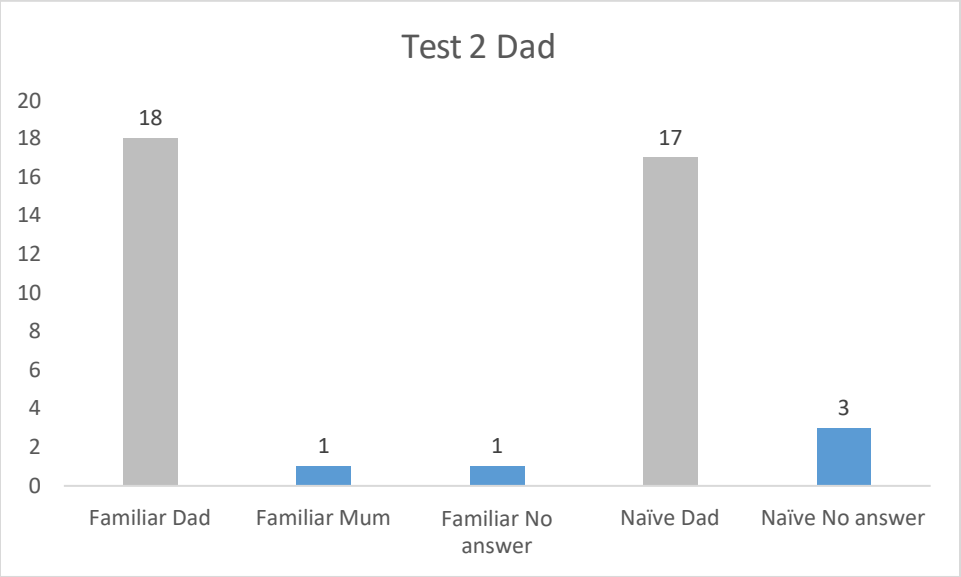


Results for Test 2b: Bus

38 listeners correctly identified the target word Bus. The target word was intelligible to 95% of listeners
20 familiar and 18 naïve listeners correctly identified Bus as the target word. 2 naïve listeners incorrectly identified the word as Mum
Familiar listeners performed slightly better than naïve listeners, having no error responses in comparison to naïve listeners where 2 error responses occurred.

Test 2c

Target word Dad



Results for Test 2c - Dad

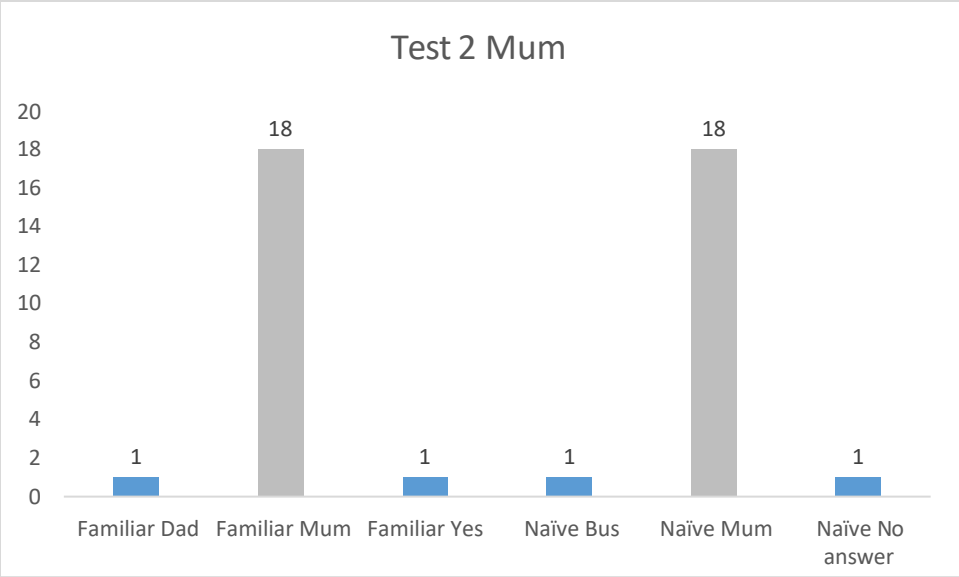
35 listeners correctly identified the target word Dad. The target word was intelligible to 87.55% of listeners
18 familiar and 17 naïve listeners correctly identified the target word. 1 familiar listener incorrectly identified the word Mum
1 familiar listener No Answer 3 naïve listeners No Answer

Familiar listeners out performed naïve listeners by only 1 for correct responses. The error pattern shows that familiar listeners had less incorrect (1) or No Answer (1) responses, compared to naïve listener with 3 No Answer responses.

The target word ‘Dad’ in this test was correctly identified by 35 listeners, and was the same word, subsequently noted to be the lowest scoring word in the earlier Test 1b, correctly identified by only 24 listeners. However, the two samples were produced by two different participants, perhaps resulting in different acoustic profiles. Possibly, exposure to the same word in the earlier test familiarised listeners with the acoustic profile, thereby achieving a higher score when repeated later in the test sequence. In addition, exposure to all test samples prior to ‘Dad’ in Test 2 may have improved listener perception with experience.

Test 2d

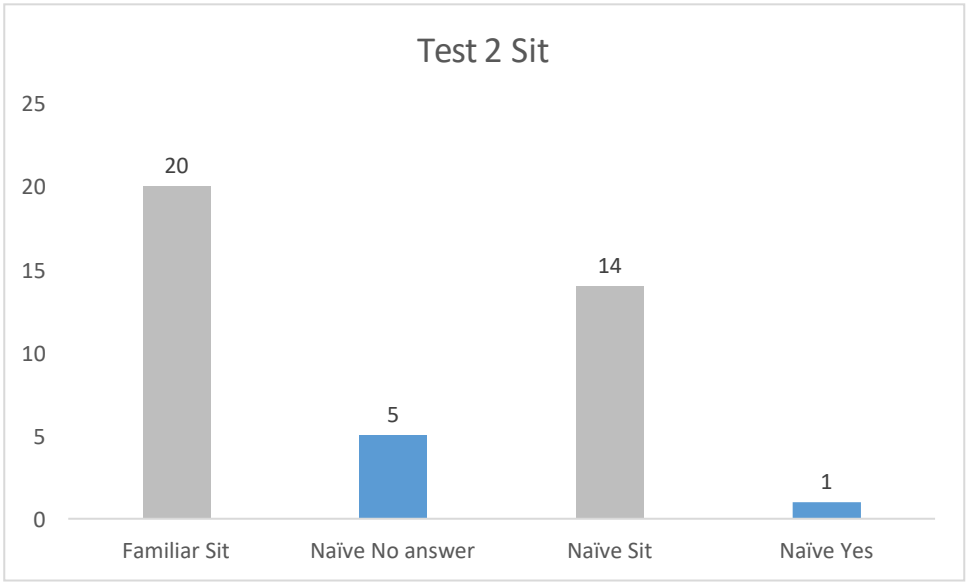
Target word Mum



Results for Test 2d

36 listeners correctly identified the target word Mum. The target word was intelligible to 90% of listeners
18 familiar listeners and 18 naïve listeners correctly identified the target word Mum 1 familiar listener incorrectly identified Dad
1 familiar listener incorrectly identified Yes 1 naïve listener incorrectly identified Bus 1 naïve listener No Answer
Although both naïve and familiar listeners achieved the same score for correct responses, there is a difference in the error pattern, showing that familiar listeners had 2 incorrect responses (Dad and Yes) while naïve listeners had 1 incorrect response, and 1 No Answer. However, the overall score indicates a high level of intelligibility for the target word for both naïve and familiar listeners
Test 2e

Target word Sit Test 2e



Results for Test 2e

Target word Sit

34 listeners correctly identified the target word Sit. The target word was intelligible to 85% of listeners
20 familiar listeners and 14 naïve listeners correctly identified the word Sit.

There was a marked difference in the scores of familiar and naïve listeners in this test.

All 20 familiar listeners correctly identified the target word, while 5 naïve listeners responded with No Answer and 1 naïve listener incorrectly identified the word Yes.
The overall score indicates a high level of intelligibility for familiar listeners, with some perceptual difficulties for naïve listeners.

Results for Test 2

Results for Test 2:were high with a total score of 183 out of a possible 200. Percentage intelligibility was above 60% for all but one listener at 40% .
Listener perception of CVC words - the influence of consonants and vowels on listener intelligibility.
Outcomes for Test 2 identify CVC words as consistently intelligible for the majority of listeners. The target words are all single syllable words, perhaps also facilitating listener ability.
This test achieved the highest score at 91.5% for intelligibility across all closed tests.Test 2 correctly scored - The table below identifies:
Scores per word
Percentage per word
Total score overall
Total percentage overall

Test 2 Correctly Scored			
Question	Word	Score	Percentage
a	Yes	40	100
b	Bus	38	95
c	Dad	35	87.5
d	Mum	36	90
e	sit	34	85
	Total	183	
	Max	200	91.5

Table: Test Two Results identifies: for Naïve and Familiar listeners

Overall scores per listener
Overall percentage per listener

Test Two Results				
Listener Number	Familiar Naïve	Correct Words	out of	Percentage
1	Familiar	5	5	100
2	Naïve	5	5	100
3	Naïve	4	5	80
4	Familiar	5	5	100
5	Naïve	5	5	100
6	Familiar	3	5	60
7	Naïve	4	5	80
8	Naïve	5	5	100
9	Naïve	3	5	60
10	Naïve	5	5	100
11	Naïve	2	5	40
12	Familiar	5	5	100
13	Familiar	5	5	100
14	Naïve	5	5	100
15	Naïve	5	5	100
16	Familiar	5	5	100
17	Naïve	3	5	60
18	Naïve	5	5	100
19	Familiar	5	5	100
20	Familiar	5	5	100
21	Naïve	5	5	100
22	Familiar	5	5	100
23	Naïve	5	5	100
24	Familiar	5	5	100
25	Naïve	5	5	100
26	Naïve	5	5	100
27	Familiar	5	5	100
28	Naïve	4	5	80
29	Familiar	3	5	60
30	Familiar	5	5	100
31	Naïve	5	5	100
32	Naïve	3	5	60
33	Familiar	5	5	100
34	Familiar	5	5	100
35	Familiar	5	5	100
36	Familiar	5	5	100
37	Familiar	5	5	100
38	Naïve	4	5	80
39	Familiar	5	5	100

40	Familiar	5	5	100

T Test results for familiar and naïve for Test 2 were p= 0.081037
Test 3

Test 3 was designed to provide data on the influence of the number of syllables and word length on the intelligibility of SV phonation.
40 listeners heard 10 words to equal 400 words

Test 3 required listeners to identify 10 words from paired options, each pair of words having an equal number of syllables.
There were:

3 single syllable pairs 4 bi-syllabic pairs
3 tri-syllabic pairs

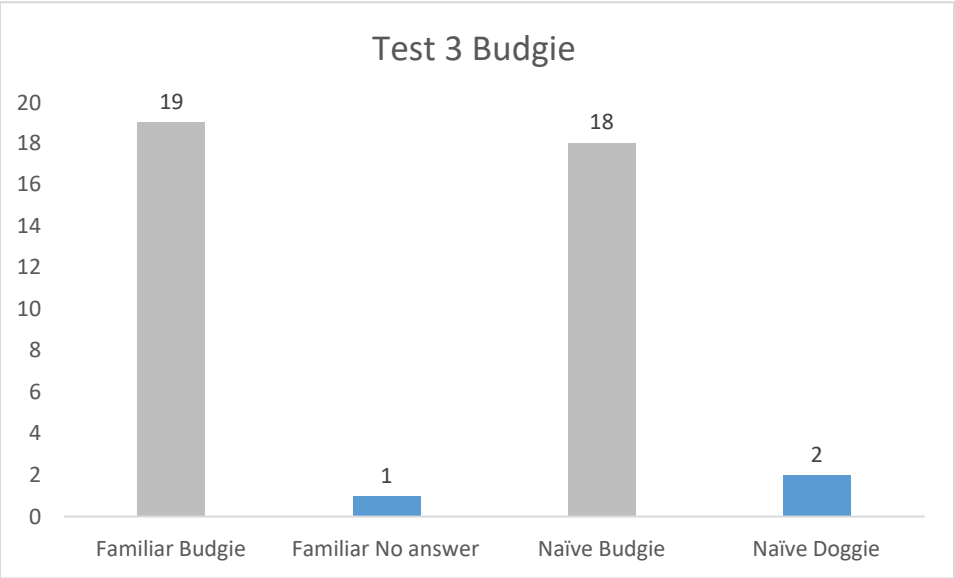
The correct target word is identified in the grid below Test 3: Paired words
There are ten pairs of words in the grid below. You will hear one word at a time from each pair. Which word do you hear?
Please tick the one you think you hear.

1. Budgie	x
Doggie	
2. Everyone	
Medicine	x
3. Yellow	
Purple	x
4. Yes	x
No	
5. Better	x

Tiger	
6. Said	x
Told	
7. Elephant	
Fabulous	x
8. Right	x
Wrong	
9. Winter	
Summer	x
10. Brilliant	x
Marvellous	

Test 3a

Target word Budgie



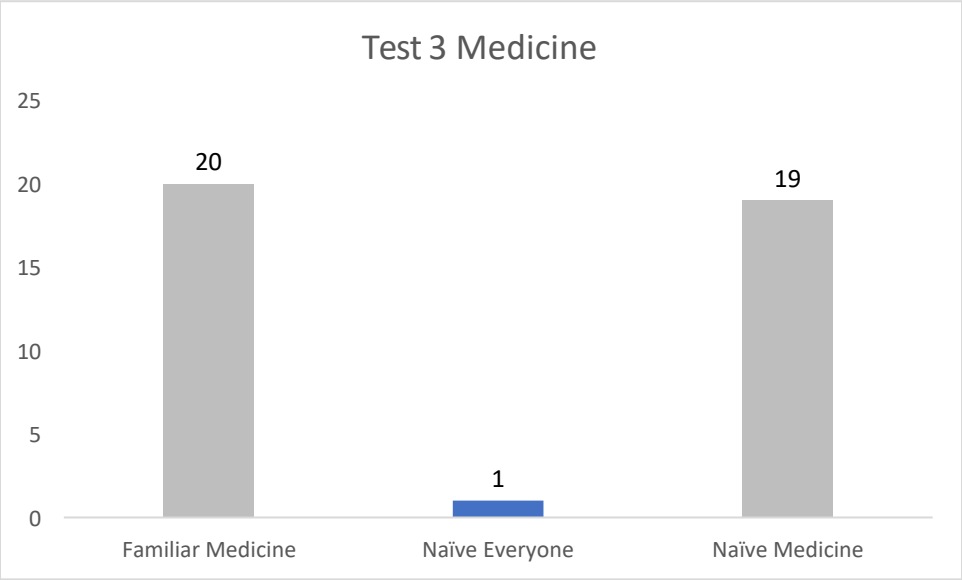
Results for Test 3a

37 listeners correctly identified the target, bi-syllabic word Budgie. The target word was intelligible to 92.5% of listeners
19 familiar listeners correctly identified the target word Budgie. 18 naïve listeners correctly identified the target word Budgie. 2 naïve listeners incorrectly identified the word Doggie
1 familiar listener No Answer

Familiar listeners (19) did marginally better in identifying the target word, with 1 No Answer for a familiar listener. Naïve listeners scored 18 correct, with 2 incorrect answers.

Test 3b

Target word Medicine

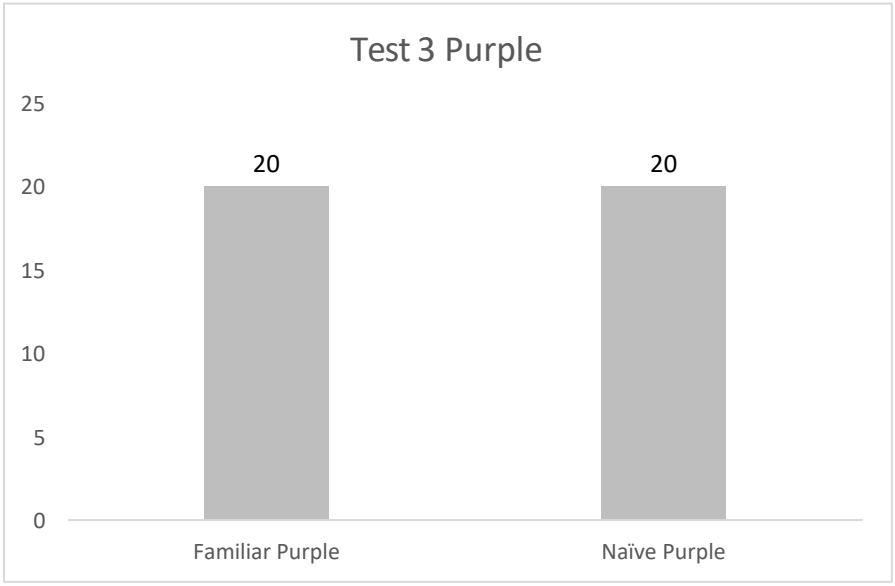


Results for Test 3b

39 correctly identified the target, tri-syllabic word Medicine. The target word was intelligible to listeners 97.5% of listeners.
20 familiar listeners correctly identified the target word Medicine. 19 naïve listeners correctly identified the target word Medicine. 1 naïve listener incorrectly identified the word Everyone

The difference between familiar and naïve listeners is marginal, with familiar listeners out- performing naïve listeners by only 1 correct response
Test 3c

Target word Purple



Results for Test 3c

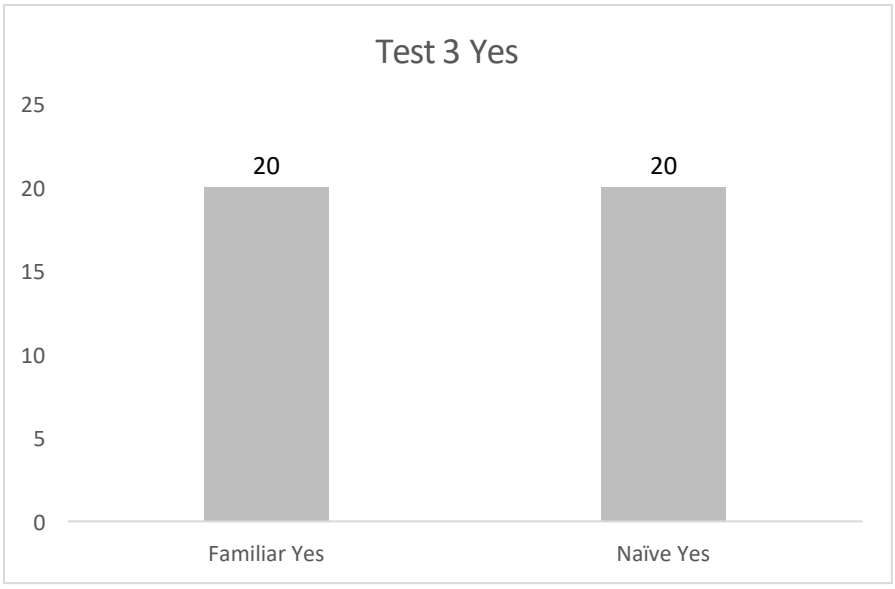
40 listeners (100%) correctly identified the target, bi-syllabic word Purple. The target word was intelligible to 100% of listeners.
20 familiar listeners correctly identified the target word Purple.

20 naïve listeners correctly identified the target word Purple.

The target word Purple achieved 100% as one of 8 highest scored words in the 7 closed tests.

Test 3d

Target word Yes



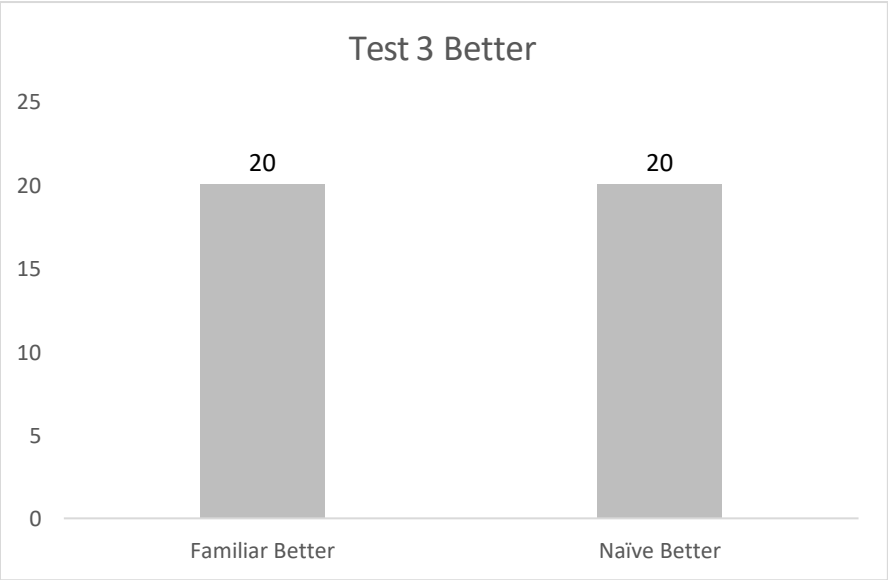
Results for Test 3d

40 listeners correctly identified the target, single syllable word Yes The target word was intelligible to 100% of listeners
20 familiar listeners correctly identified the target word Yes. 20 naïve listeners correctly identified the target word Yes.
There was no difference between familiar and naïve listeners.
The target word Yes achieved 100% as one of 8 highest scored words in the 7 closed tests.

The word Yes appeared previously in Test 2, so some degree of listener learning may have occurred across the tests. The single syllable may also have contributed to the 100% identification of this word, although the utterances Yes were produced by different participants (Yes in Test 2 by E and Yes in Test 3 by S.P.)

Test 3e

Target word Better



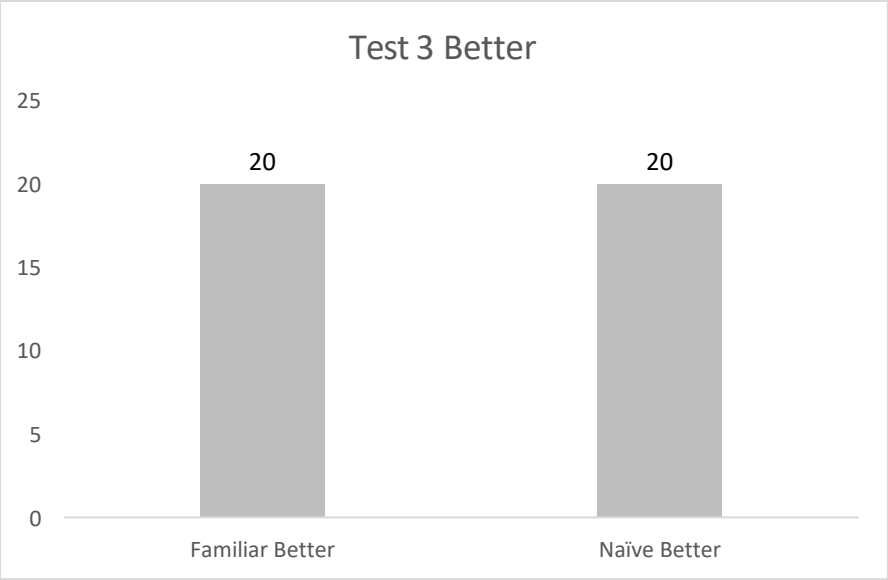
Results for Test 3e

40 listeners correctly identified the target, bi-syllabic word Better.

The target word was intelligible to 100% of listeners.

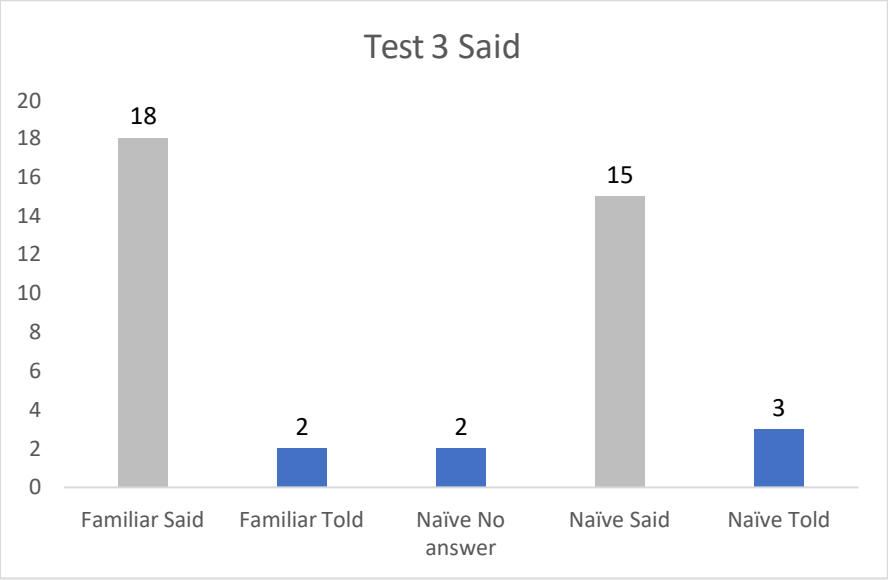
20 familiar listeners correctly identified the target word Better.

20 naïve listeners correctly identified the target word Better. There was no difference between familiar and naïve listeners.
The target word Better achieved 100% as one of 8 highest scored words in the 7 closed tests.



Test 3f

Target word Said



Results for Test 3f

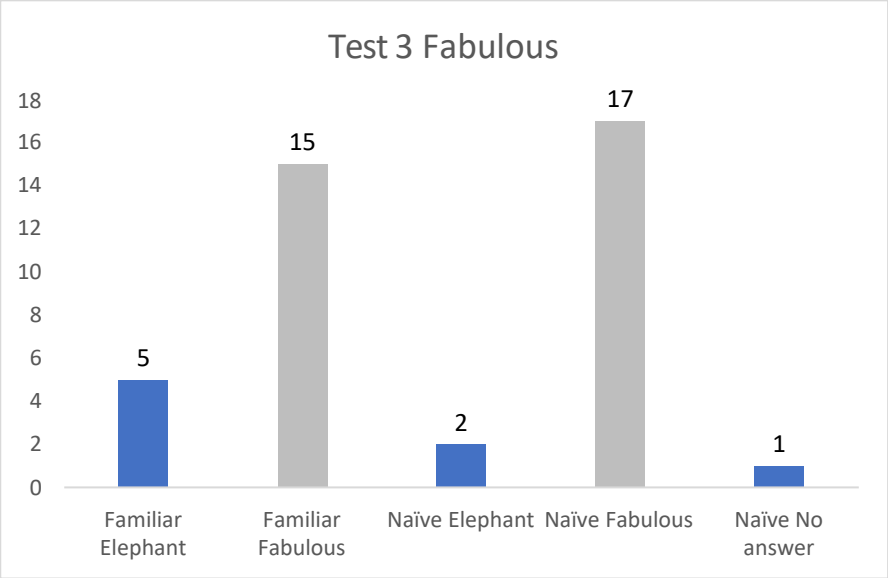
33 listeners correctly identified the target, single syllabic word Said.

The target word was intelligible to 82.5% of listeners.

18 familiar listeners correctly identified the target word Said. 15 naïve listeners correctly identified the target word Said.
2 familiar listeners incorrectly identified the word Told
3 naïve listeners incorrectly identified the word Told 2 naïve listeners No Answer
Familiar listeners performed better with this word, having 2 incorrect responses, in comparison with naïve listeners who had 3 incorrect responses and 2 No Answer responses.

Test 3g

Target word Fabulous



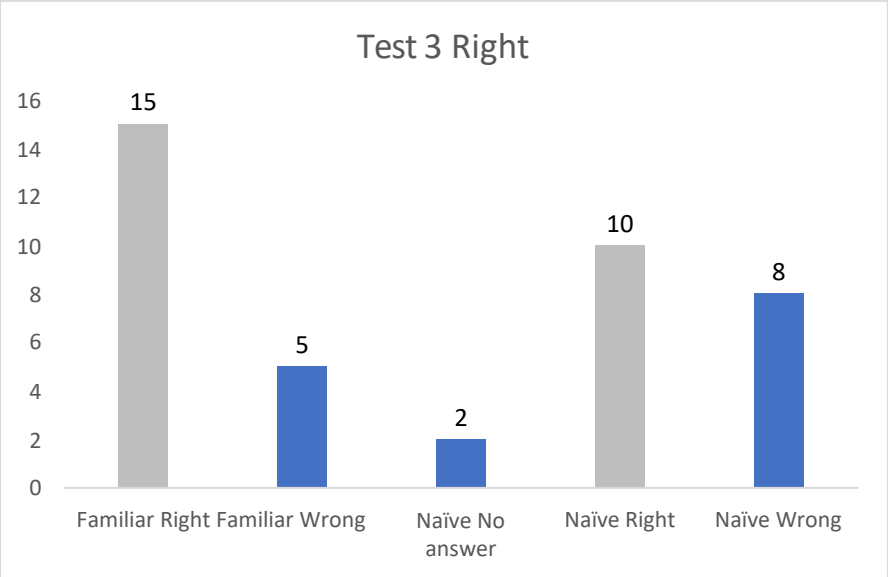
Results for Test 3g

32 listeners correctly identified the target, tri-syllabic word Fabulous. The target word was intelligible to 80% of listeners
15 familiar listeners correctly identified the target word Fabulous. 17 naïve listeners correctly identified the target word Fabulous. 5 familiar listeners incorrectly identified the word Elephant
2 naïve listeners incorrectly identified the word Elephant 1 naïve listener No Answer

17 naïve listeners out-performed 15 familiar listeners by correctly identifying the target word on this test. The error pattern too, shows that familiar listeners (5) made more errors in comparison to errors by naïve listeners (2) and I No Answer response.

Test 3h

Target word Right



Results for Test 3h

25 listeners correctly identified the target, single syllabic word Right.

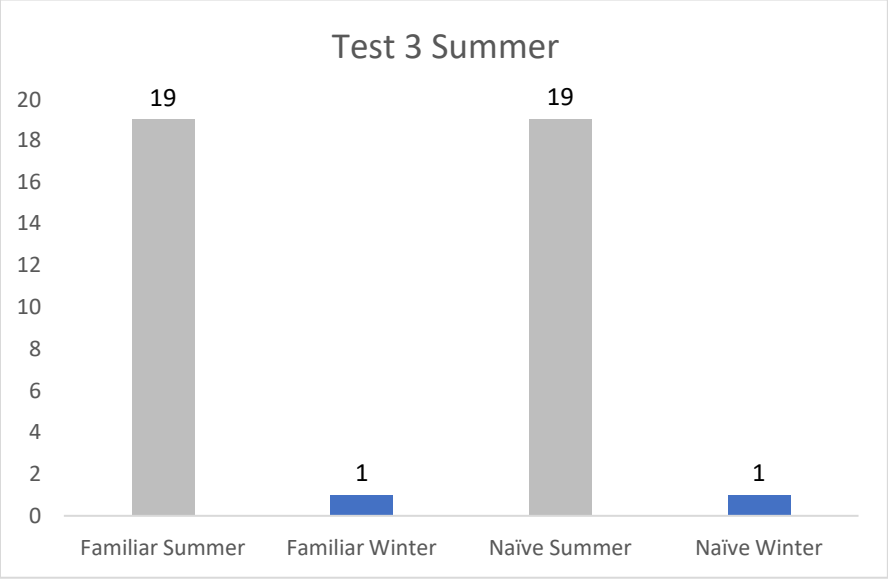
The target word was intelligible to 62.5% of listeners.

15 familiar listeners correctly identified the target word Right. 10 naïve listeners correctly identified the target word Right. 5 familiar listeners incorrectly identified the word Wrong
8 naïve listeners incorrectly identified the word Wrong 2 naïve listeners No Answer

Familiar listeners scored better with 15 correct responses, compared to only 10 correct responses by naïve listeners.
Familiar listeners had fewer incorrect responses (5) compared to naïve listeners (8) and 2 No Answer responses by naïve listeners.
The two paired words in this test are phonetically very similar in having an initial [r] (due to the silent ‘w’ in wrong) that may have contributed to listener error.
The single syllable word Right achieved the lowest score (62.5%) overall on this test.

Test 3i

Target word Summer



Results for Test 3i

38 listeners correctly identified the target, bi-syllabic word Summer.

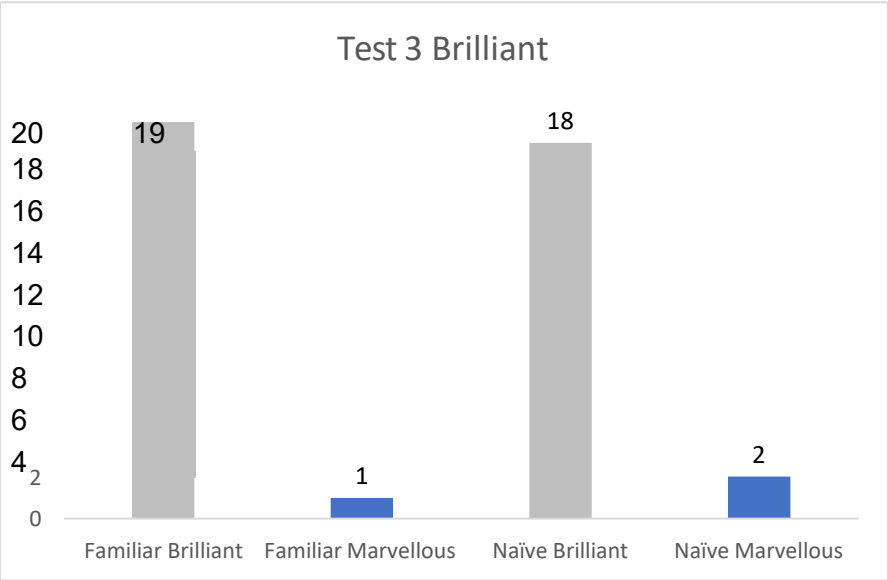
The target word was intelligible to 95% of listeners

19 familiar listeners correctly identified the target word Summer. 19 naïve listeners correctly identified the target word Summer. 1 familiar listener incorrectly identified the word Winter
1 naïve listener incorrectly identified the word Winter

There was no difference between familiar and naïve listeners in this test.

Test 3j

Target word Brilliant



Results for Test 3j

37 listeners correctly identified the target word Brilliant.

The target word was intelligible to 92.5% of listeners.

19 familiar listeners correctly identified the target word Brilliant. 18 naïve listeners correctly identified the target word Brilliant. 1 familiar listener incorrectly identified the word Marvellous
2 naïve listeners incorrectly identified the word Marvellous.

Familiar listeners scored better than naïve listeners on this test, with 19 correct responses compared to 18 correct responses by naïve listeners. Familiar listeners also had fewer errors (1) compared to naïve errors (2).
The influence of the number of syllables and word length on intelligibility. Results showed that:
Bi-syllabic words achieved 155. Tri-syllabic words achieved 108 Single syllable words achieved 98.
Results from this test do identify bi-syllabic words as those best perceived by listeners. Bi-syllabic words perhaps carry more perceptually available information than would single syllable words, thus achieving a higher score. However, if listener responses are influenced by the increase in information carrying syllables, tri-syllabic words should outperform other options, offering information across three syllables. This is not the case in this test, and it is possible that respiratory energy is sufficient for clarity

on bi-syllabic options, providing more information than single syllable words, but begins to reduce for longer words and thus reduces perceptually available information.
There was an imbalance in the number of pairs in this test, with 4 bi-syllabic pairs, compared to three tri-syllabic pairs and 3 single syllable pairs. However, had an extra single syllable and tri-syllabic pair been added, potentially achieving scores of 40 (100%) each, scores would still have identified the bi-syllabic pairs as most intelligible. Nevertheless, a future test should be constructed with an equal number of pairs to ensure validity of outcomes.
Consideration was given to an examination of syllabic results in the other closed tests, in order to relate syllabic length to outcomes, but the presence of emphasis on other factors, for example CVC structure or degrees of phonetic variation, meant that the relevance of syllabic structure alone could not be determined..

Test 3 achieved the second highest overall score on the closed tests - 361/400 90.25%

Overall outcomes for Test 3

Table A below identifies:

Scores per word
Percentage per word
Total score overall
Total percentage overall

Question 3 Correctly Scored			
Question	Word	Score	Percentage
a	Budgie	37	92.5
b	Medicine	39	97.5
c	Purple	40	100
d	Yes	40	100
e	Better	40	100
f	Said	33	82.5
g	Fabulous	32	80
h	Right	25	62.5
i	Summer	38	95
j	Brilliant	37	92.5
	Total	361	
	Max	400	90.25

Table B identifies: for Naïve and Familiar listeners

Overall scores per listener
Overall percentage per listener

Test Three Results				
Listener Number	Familiar Naïve	Correct Words	Out OF	Percentage
1	Familiar	10	10	100
2	Naïve	9	10	90
3	Naïve	10	10	100
4	Familiar	10	10	100
5	Naïve	9	10	90
6	Familiar	10	10	100
7	Naïve	9	10	90
8	Naïve	9	10	90
9	Naïve	9	10	90
10	Naïve	8	10	80
11	Naïve	9	10	90
12	Familiar	9	10	90
13	Familiar	9	10	90
14	Naïve	9	10	90
15	Naïve	8	10	80
16	Familiar	10	10	100
17	Naïve	9	10	90
18	Naïve	9	10	90
19	Familiar	9	10	90
20	Familiar	10	10	100
21	Naïve	9	10	90

22	Familiar	9	10	90
23	Naïve	8	10	80
24	Familiar	9	10	90
25	Naïve	8	10	80
26	Naïve	9	10	90
27	Familiar	10	10	100
28	Naïve	10	10	100
29	Familiar	10	10	100
30	Familiar	8	10	80
31	Naïve	9	10	90
32	Naïve	10	10	100
33	Familiar	9	10	90
34	Familiar	10	10	100
35	Familiar	8	10	80
36	Familiar	8	10	80
37	Familiar	9	10	90
38	Naïve	6	10	60
39	Familiar	9	10	90
40	Familiar	9	10	90

T Test Results for Familiar and Naïve for Test 3 were p= 0.0875

Test 4

Test 4 was designed to provide data the ability of listeners to discern marked phonetic differences
The correct words are entered in the grid below

Test 4.

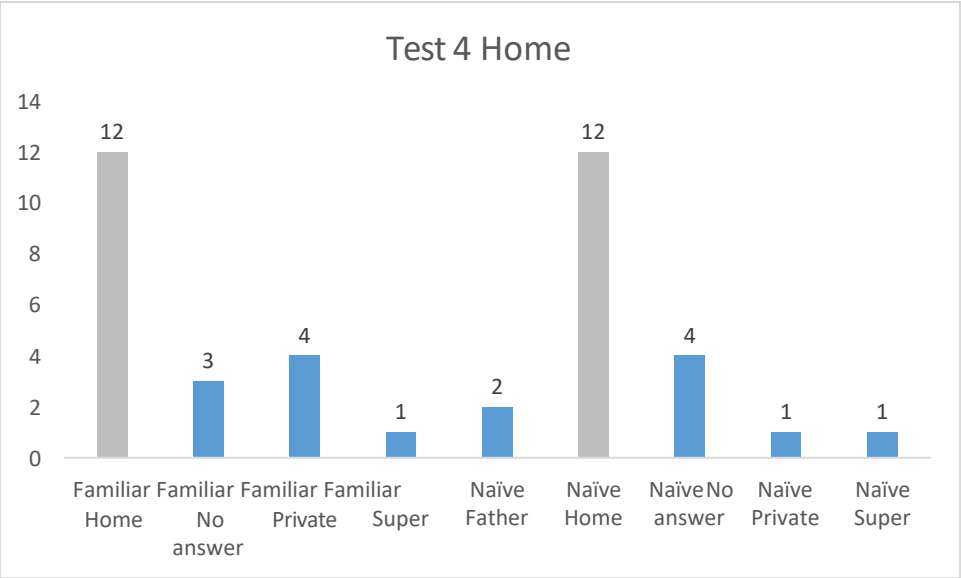
You will hear six words, one at a time, from the list below. Please write each word in the grid below as you hear it. If you do not recognise a word, please leave the box blank. Some words might be repeated.

Christmas Super Father Care Private Home

Sample 1	Home
Sample 2	Father
Sample 3	Christmas
Sample 4	Super
Sample 5	Care
Sample 6	Private

Test 4a

Target word Home



Results for Test 4a

24 listeners correctly identified the target word Home.

The target word was intelligible to 60% of listeners

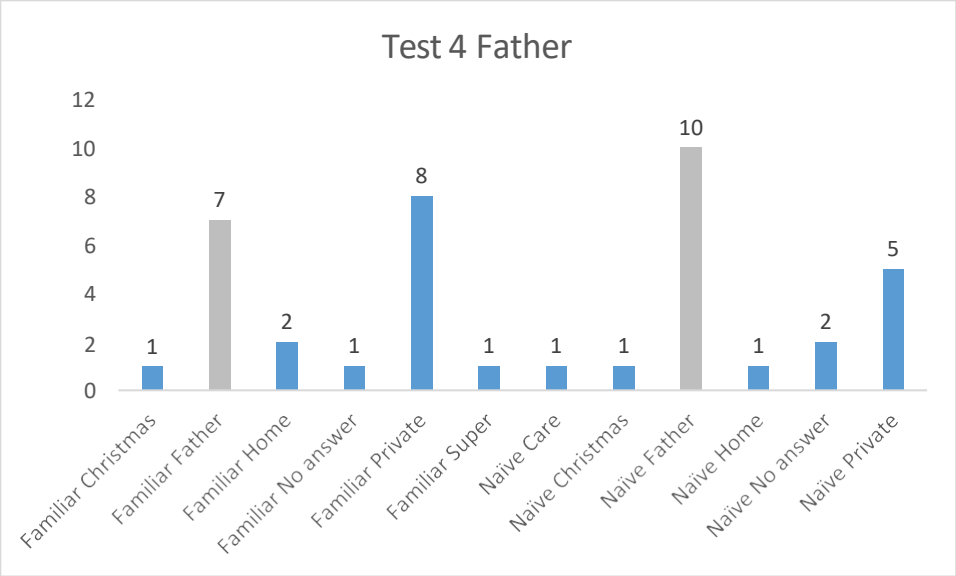
12 familiar listeners correctly identified the target word Home. 12 naïve listeners correctly identified the target word Home. 4 familiar listeners incorrectly identified the word Private
1 naïve listener incorrectly identified the word Private 1 familiar listener incorrectly identified the word Super

1 naive listener incorrectly identified the word Super 2 naive listeners incorrectly identified the word Father 3 familiar listeners No Answer
4 naïve listeners No Answer

An equal number of naïve and familiar listener correctly identified the target word and an equal number of naïve and familiar listeners made incorrect responses. The error pattern shows scatter across all options, with listeners perceiving bi-syllabic words instead of the single syllable target. The only other single syllable word available (Care) was not included in any responses.
There are 7 No Answer responses and this, in conjunction with the low correct score and the wide error patter suggest that this sample challenged perception for both naïve and familiar listeners.

Test 4b

Target word Father



Results for Test 4b

17 listeners correctly identified the target word Father.

The target word was intelligible to 42.5.% of listeners

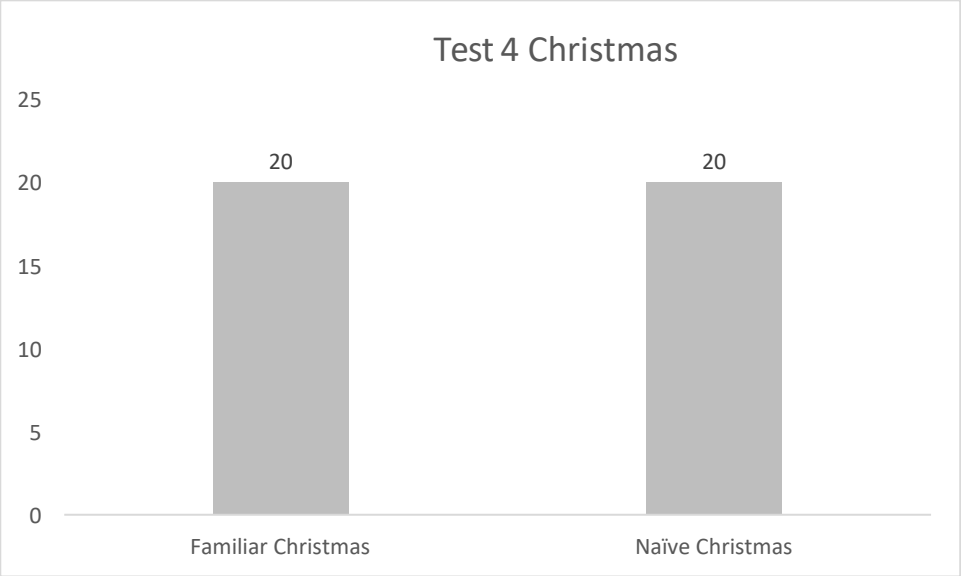
7 familiar listeners correctly identified the target word Father. 10 naïve listeners correctly identified the target word Father. 8 familiar listeners incorrectly identified the word Private
5 naive listeners incorrectly identified the word Private 1 familiar listener incorrectly identified the word Super 1 naive listener incorrectly identified the word Care
1 familiar listener incorrectly identified the word Christmas

1 naïve listener incorrectly identified the word Christmas 2 familiar listeners incorrectly identified the word Home 1 naive listener incorrectly identified the word Home
1 familiar listener No Answer 2 naïve listeners No Answer

Selection of the correct response is very low (42.5) with (10) naïve listeners out performing (7) familiar listeners. The error pattern shows wide scatter, with every option other than the target word being selected. The word Private was selected more than any other option, with 13 responses overall (8 familiar and 5 naïve) possibly due to the bi-syllabic similarity but results indicate that the majority of listeners (23) were perceptually challenged by this SV utterance.

Test 4c

Target word Christmas



Results for Test 4c

40 listeners correctly identified the target word Christmas.

The target word was intelligible to 100% of listeners

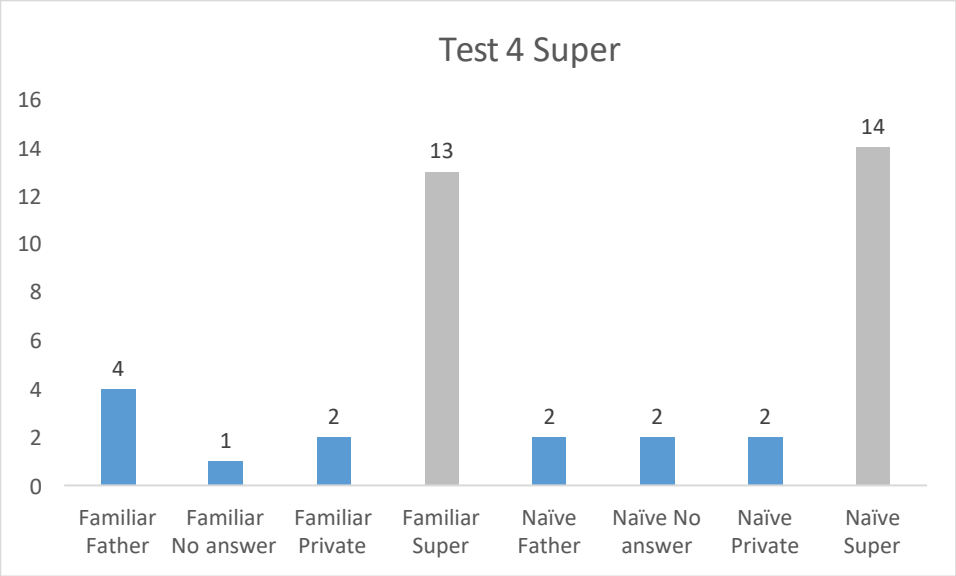
20 familiar listeners correctly identified the target word Christmas.

20 naïve listeners correctly identified the target word Christmas

The 100% correct response for this utterance identified it as easily perceived by both familiar and naïve listeners.

Test 4d

Target word Super



Results for Test 4d

27 listeners (67.5%) correctly identified the target word Super.

The target word was intelligible to 67.5% of listeners.

13 familiar listeners correctly identified the target word Super. 14 naïve listeners correctly identified the target word Super. 4 familiar listeners incorrectly identified the word Father
2 naive listeners incorrectly identified the word Father

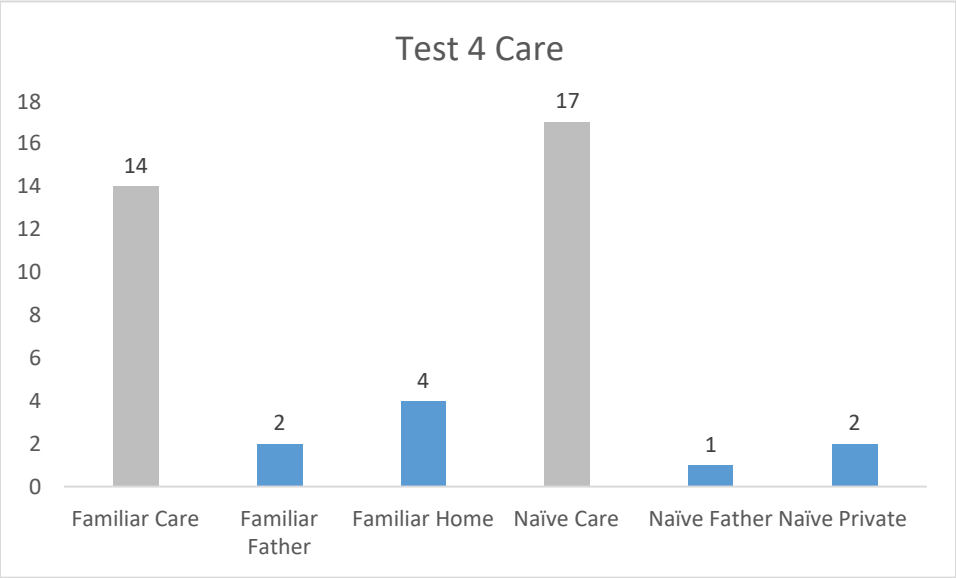
2 familiar listeners incorrectly identified the word Private 2 naive listeners incorrectly identified the word Private 1 familiar listener No Answer

2 naïve listeners No Answer

Naïve listeners outperformed familiar listeners for this target word, having 1 more correct response and 1 less incorrect response than familiar listeners. The error pattern shows selection of other bi-syllabic words Private and Father, but in conjunction with 3 No Answer responses. That the single syllable word was not selected in error suggests that listeners did perceive two syllables in Father and Private, yet were unable to decode either syllable sufficiently for them to be any more intelligible than the target word Super.

Test 4e

Target word Care



Results for Test 4e

31 listeners correctly identified the target word Care.

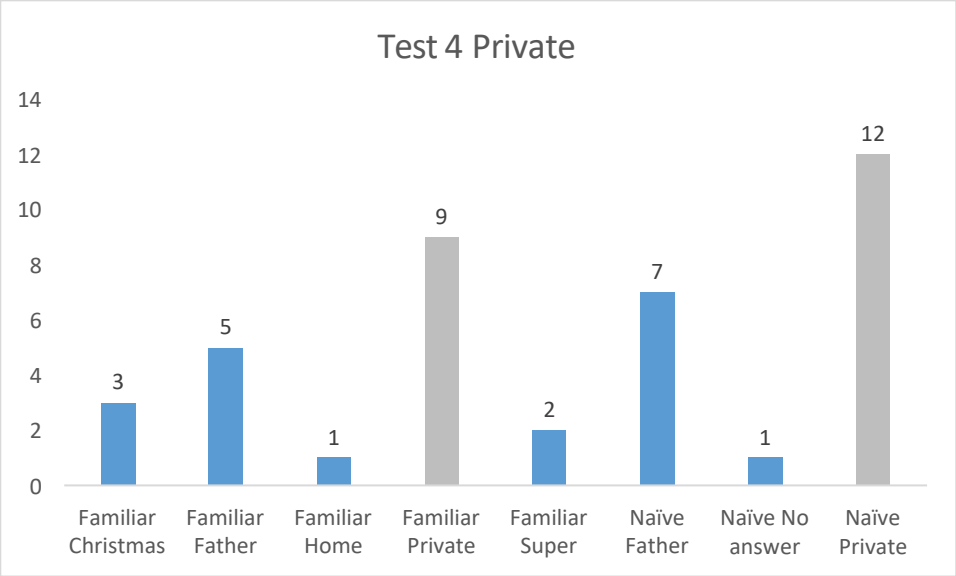
The target word was intelligible to 77.5% of listeners.

14 familiar listeners correctly identified the target word Care. 17 naïve listeners correctly identified the target word Care 4 familiar listeners incorrectly identified the word Home 2 familiar listeners incorrectly identified the word Father 1 naive listeners incorrectly identified the word Father 2 naive listeners incorrectly identified the word Private

Naïve listeners (17) achieved better scores than did familiar listeners (14) and had fewer errors (3) compared to familiar listeners with 6 errors. Naïve listeners out performed familiar listeners. The error pattern shows that 5 listeners incorrectly identified the single syllable word Home, but 5 listeners opted for the bi-syllabic alternatives, Father and Private, appearing to perceive more phonetic information than was available in the SV utterance.

Test 4f

Target word Private



Results for Test 4f

21 listeners correctly identified the target word Private.

The target word was intelligible to 52.5% of listeners.

9 familiar listeners correctly identified the target word Private. 12 naïve listeners correctly identified the target word Private 5 familiar listeners incorrectly identified the word Father
7 naive listeners incorrectly identified the word Father

3 familiar listeners incorrectly identified the word Christmas 2 naive listeners incorrectly identified the word Super
1 familiar listener incorrectly identified the word Home 1 naïve No Answer.

The number of correct responses (21) almost match the number of incorrect responses (19) indicating that a significant number of listeners were perceptually challenged by this utterance.
The scatter across this test is quite marked, as low correct scores also resulted in variation on alternative words selected by listeners. This suggests limited intelligibility for these utterances, as listeners varied considerably in their interpretation.
The error pattern shows a high number of incorrect responses for Father (12) for both familiar (5) and naïve listeners (7) suggesting that the utterance had similar phonetic features to the target word Private. Reference back to the earlier test for the word Father shows a similar error pattern, where 13 listeners incorrectly selected Private. Some listeners in both tests apparently had difficulty in distinguishing between the two bi-syllabic utterances. suggesting some phonetic and/or syllabic similarity between Father and Private that listeners found hard to differentiate. Perceptually, both words appeared to have similar phonetic features and scored the two lowest overall scores, as below, possibly due to the similar phonetic/acoustic pattern.
Private 21 correct 52.5.%

Father 17 correct 42.5.%

Interestingly, Christmas was incorrectly selected by 3 familiar listeners, although this utterance had achieved 100% correct response earlier in the test. This does demonstrate that listeners did anticipate repetition of target words, following the test instruction ‘Some words might be repeated.’

Naïve listeners out performed familiar listeners with more correct responses (12) than familiar listeners (9)
The ability of listeners to discern marked phonetic differences

Test 4 presents listeners with a similar perceptual challenge as seen in 1d and 1e, where the options available are markedly dissimilar but identification of the target word appears to be particularly problematic. The error pattern shows wide scattered across these tests, suggesting that listener perception is challenged when required to scan across markedly different options.
In contrast to the other target words, it is noticeable that Christmas was among the 8 highest scored words across all closed tests, with 40 correct responses (100%) Listeners readily identified this target and listener perception may have benefitted from the use of Christmas as a proper noun of some significance to most listeners.
Overall outcomes for Test 4

Table A below identifies:

Scores per word
Percentage per word
Total score overall
Total percentage overall

Question 4 Correctly Scored			
Question	Word	Score	Percentage
a	Home	24	60

b	Father	17	42.5
c	Christmas	40	100
d	Super	27	67.5
e	Care	31	77.5
f	Private	21	52.5
	Total	160	
	Max	240	66.7

Table B identifies: for Naïve and Familiar listeners

Overall scores per listener
Overall percentage per listener
Niave and familiar listeners

Test Four Results				
Listener Number	Familiar Naïve	Correct Words	Out of	Percentage
1	Familiar	6	6	100
2	Naïve	4	6	67
3	Naïve	4	6	67
4	Familiar	3	6	50
5	Naïve	4	6	67

6	Familiar	2	6	33
7	Naïve	5	6	83
8	Naïve	4	6	67
9	Naïve	5	6	83
10	Naïve	4	6	67
11	Naïve	2	6	33
12	Familiar	2	6	33
13	Familiar	3	6	50
14	Naïve	6	6	100
15	Naïve	6	6	100
16	Familiar	4	6	67
17	Naïve	4	6	67
18	Naïve	4	6	67
19	Familiar	4	6	67
20	Familiar	2	6	33
21	Naïve	5	6	83
22	Familiar	2	6	33
23	Naïve	5	6	83
24	Familiar	4	6	67
25	Naïve	5	6	83
26	Naïve	3	6	50
27	Familiar	4	6	67
28	Naïve	4	6	67
29	Familiar	5	6	83

30	Familiar	2	6	33
31	Naïve	4	6	67
32	Naïve	4	6	67
33	Familiar	4	6	67
34	Familiar	4	6	67
35	Familiar	4	6	67
36	Familiar	6	6	100
37	Familiar	5	6	83
38	Naïve	3	6	50
39	Familiar	6	6	100
40	Familiar	3	6	50

T Test Results for Familiar and Naïve for Test 4 were p= 0191505

Test 5

40 listeners heard 5 words to equal 200 words

Test 5 provides information on the influence of semantic context on intelligibility of SV phonation, using 5 words relating to colour
The correct target words are placed in the grid below

Test 5

You will hear the names of different colours from the list below.

Please write each colour in the grid below as you hear it.

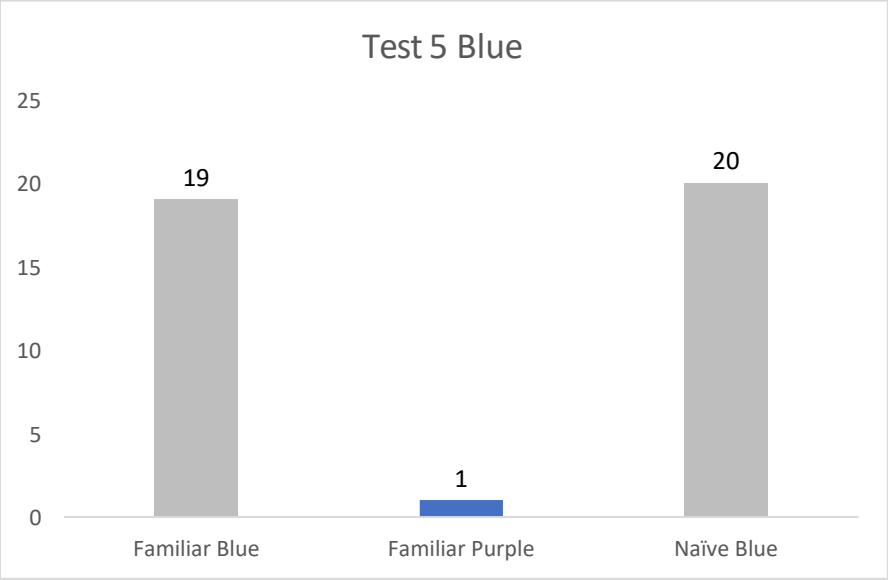
If you do not recognise a colour, please leave the box blank. Some words might be repeated.
Purple Blue Red Yellow Orange

Sample 1	Blue
Sample 2	Yellow
Sample 3	Red
Sample 4	Orange

Sample 5	Purple

Test 5a

Target word Blue



Results for Test 5a

39 listeners correctly identified the target word Blue. The target word was intelligible to 97.5% of listeners

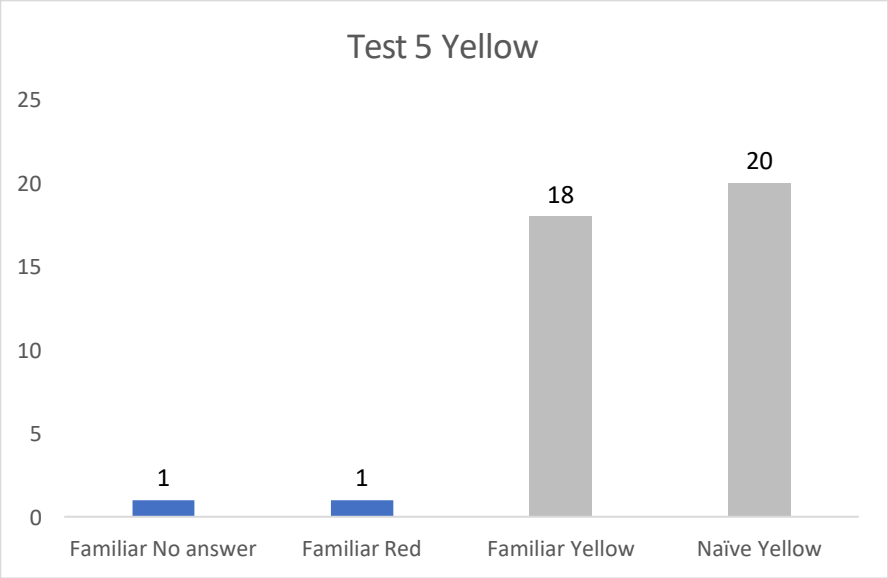
familiar listeners correctly identified the target word Blue.

naïve listeners correctly identified the target word Blue 1 familiar listener incorrectly identified the word Purple

The majority of responses clearly identified the target word, with only 1 familiar listener returning an incorrect response. On this basis, naïve listeners out performed familiar listeners by a very small margin.

Test 5b

Target word Yellow



Results for Test 5b

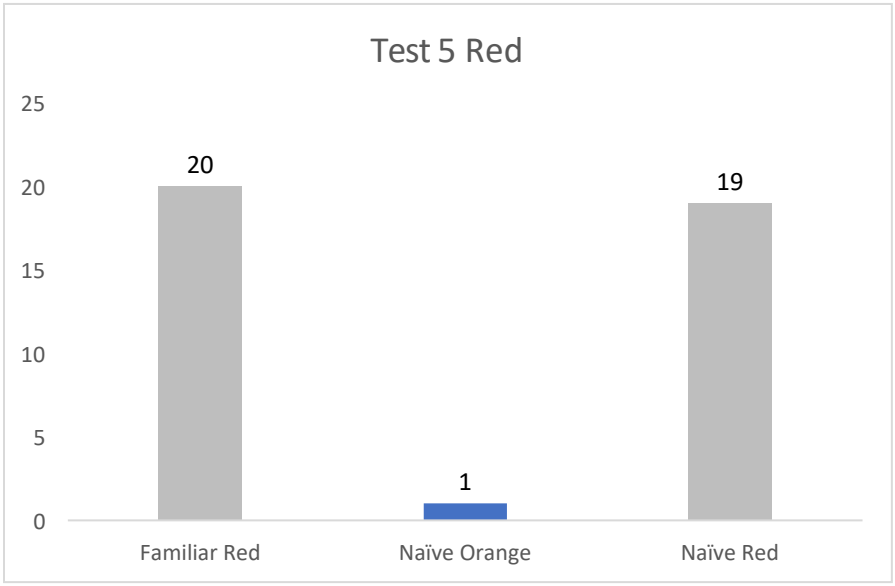
38 listeners correctly identified the target word Yellow.

The target word was intelligible to 95% of listeners.

18 familiar listeners correctly identified the target word Yellow. 20 naïve listeners correctly identified the target word Yellow
1 familiar listener incorrectly identified the word Red 1 familiar No Answer
The majority of responses clearly identified the target word, with only 1 familiar listener returning an incorrect response and 1 familiar listener a No Answer response. On this basis, naïve listeners out performed familiar listeners by a small margin.

Test 5c

Target word Red



Results for Test 5c

39 listeners correctly identified the target word Red.

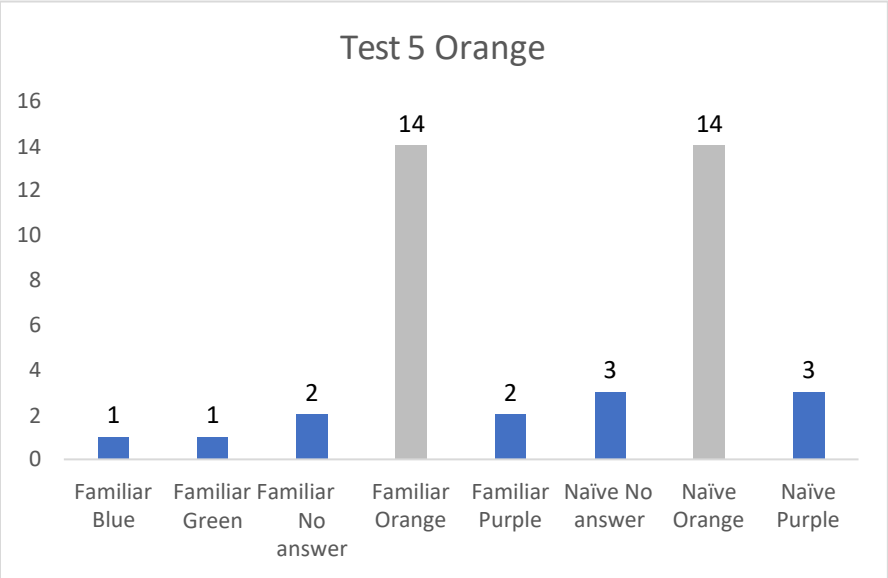
The target word was intelligible to 97.5% of listeners.

20 familiar listeners correctly identified the target word Red. 19 naïve listeners correctly identified the target word Red
1 naive listener incorrectly identified the word Orange

The majority of responses clearly identified the target word, with only 1 naïve listener returning an incorrect response. On this basis, familiar listeners out performed naive listeners by a very small margin.

Test 5d

Target word Orange



Results for Test 5d

28 listeners correctly identified the target word Orange.

The target word was intelligible to 70% of listeners.

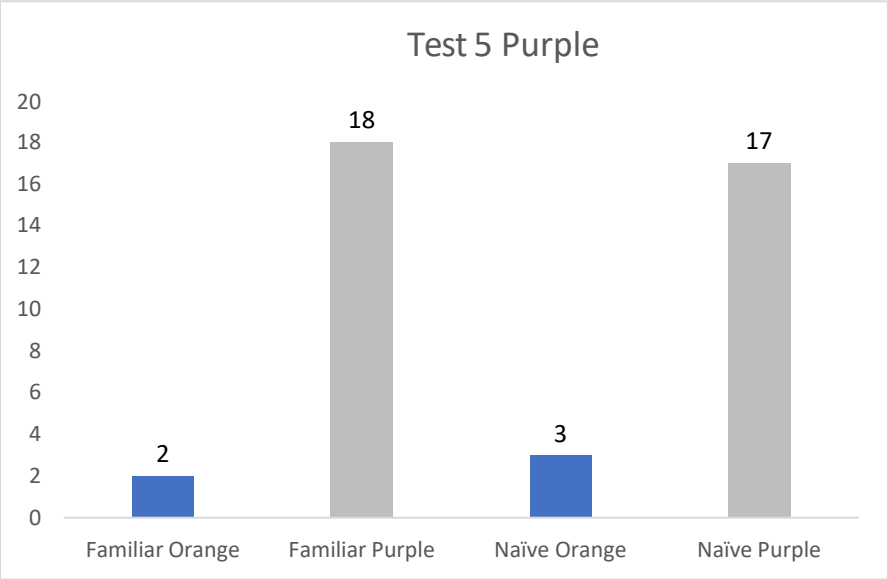
14 familiar listeners correctly identified the target word Orange. 14 naïve listeners correctly identified the target word Orange
familiar listener incorrectly identified the word Blue 1 familiar listener incorrectly identified the word Green
familiar listeners incorrectly identified the word Purple 2 familiar listeners No Answer
naïve listeners No Answer

3 naïve listener incorrectly identified the word Purple

Although a 70% correct response is not a low score per se, the target word Orange achieved the lowest score in this test, in comparison with the other target words.
The error pattern shows 5 No Answer responses (2 familiar, 3 naïve) and 5 incorrect responses for the word Purple. Although Purple is also bi-syllabic, as is orange, the bi-syllabic utterance yellow was not selected, suggesting that listeners did not rely on syllable length. This is supported by the presence of 2 incorrect responses of (1) Blue and (1) Green by familiar listeners.
Naïve and familiar listeners achieved equal results, with 14 correct responses each and 6 incorrect responses each.

Test 5e

Target word Purple



Results for Test 5e

35 listeners (87.5) correctly identified the target word Purple.

The target word was intelligible to 87.5% of listeners.

18 familiar listeners correctly identified the target word Purple. 17 naïve listeners correctly identified the target word Purple

2 familiar listeners incorrectly identified the word Orange 3 naïve listeners incorrectly identified the word Orange

The word Purple in this test had been used previously (Test 3) and, although both utterances had been produced by different participants, listeners had previous exposure to the word.
Familiar listeners out performed naïve listeners with 18 familiar correct responses compared to 17 naïve correct responses. The error pattern shows that familiar listeners made fewer errors (2) compared to naïve listeners (3)
5 listeners incorrectly identified the utterance Purple as Orange, reversing the outcome of the previous test where 5 listeners identified Orange as Purple, suggesting some phonetic and/or syllabic similarity between these utterances that listeners found hard to differentiate.

The influence of semantic context (colour) on intelligibility of SV phonation.

Listeners achieved high scores for all target words in this test, with the lowest scored word Orange achieving 70%. The semantic context of colour did appear to aid perception and thus intelligibility of SV utterances.

Overall outcomes for Test 5

Table A below identifies:

Scores per word
Percentage per word
Total score overall
Total percentage overall

Question 5 Correctly Scored			
Question	Word	Score	Percentage
a	Blue	39	97.5
b	Yellow	38	95
c	Red	39	97.5
d	Orange	28	70
e	Purple	35	87.5
	Total	179	
	Max	200	89.5

Table B identifies: for Naïve and Familiar listeners

Overall scores per listener
Overall percentage per listener
Naïve and familiar listeners

Test Five Results				
Listener Number	Familiar Naïve	Correct Words	Out of	Percentage
1	Familiar	3	5	60
2	Naïve	5	5	100
3	Naïve	5	5	100
4	Familiar	5	5	100
5	Naïve	5	5	100
6	Familiar	5	5	100
7	Naïve	2	5	40
8	Naïve	5	5	100
9	Naïve	5	5	100
10	Naïve	3	5	60
11	Naïve	4	5	80
12	Familiar	5	5	100
13	Familiar	5	5	100
14	Naïve	5	5	100
15	Naïve	5	5	100
16	Familiar	5	5	100
17	Naïve	5	5	100
18	Naïve	5	5	100
19	Familiar	5	5	100

20	Familiar	5	5	100
21	Naïve	5	5	100
22	Familiar	3	5	60
23	Naïve	5	5	100
24	Familiar	5	5	100
25	Naïve	5	5	100
26	Naïve	4	5	80
27	Familiar	5	5	100
28	Naïve	5	5	100
29	Familiar	3	5	60
30	Familiar	5	5	100
31	Naïve	5	5	100
32	Naïve	4	5	80
33	Familiar	3	5	60
34	Familiar	5	5	100
35	Familiar	4	5	80
36	Familiar	4	5	80
37	Familiar	5	5	100
38	Naïve	3	5	60
39	Familiar	4	5	80
40	Familiar	5	5	100

T Test Results for Familiar and Naïve for Test 5 were p= 585165

Test 6

Test 6 was designed to provide additional information on the influence of semantic context (Animals) on intelligibility of SV phonation
40 listeners heard 5 words to equal 200 words.

The correct target words are placed in the grid below

Test 6

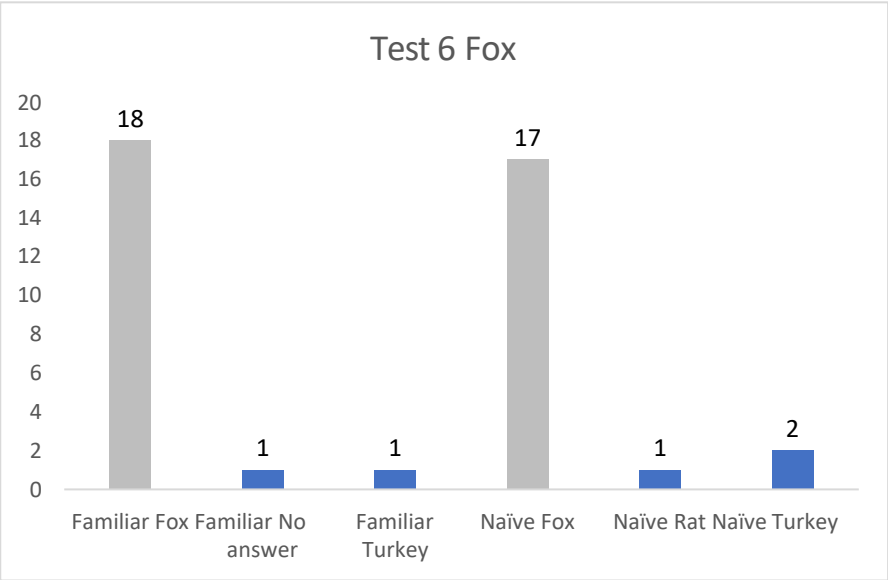
You will hear the names of different animals from the list below. Please write each animal in the grid below as you hear it.
If you do not recognise an animal, please leave the box blank. Some words might be repeated.
Turkey Fox Sheep Rat Pig

Sample 1	Fox
Sample 2	Sheep
Sample 3	Pig

Sample 4	Rat
Sample 5	Turkey

Test 6a

Target word Fox



Results of Test 6a

35 listeners correctly identified the target word Fox. The target word was intelligible to 87.5 listeners

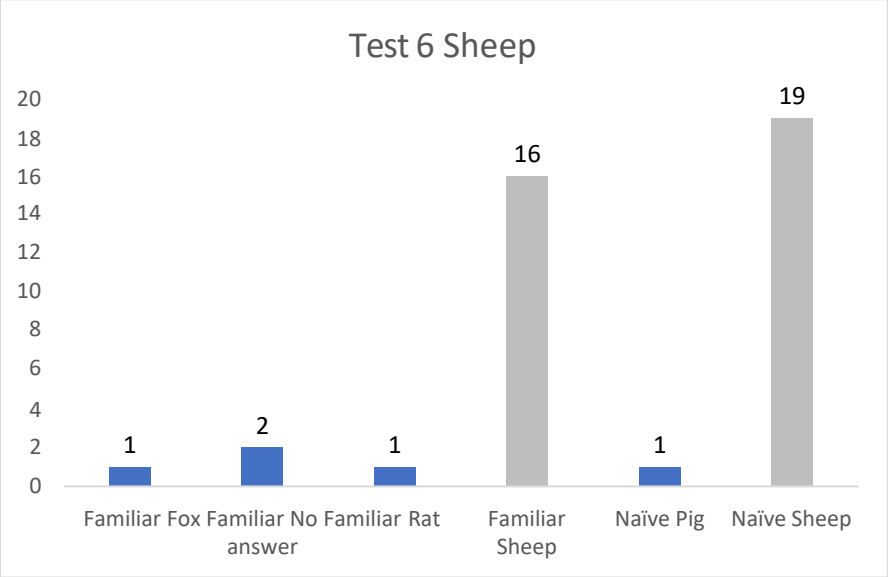
18 familiar listeners correctly identified the target word Fox.

17 naïve listeners correctly identified the target word Fox 1 familiar listener incorrectly identified the word Turkey
2 naïve listeners incorrectly identified Turkey 1 naive listener incorrectly identified Rat
1 familiar listener No Answer

Familiar and naïve listeners achieved similar results, with familiar listeners having 1 more correct response than naïve listeners and 1 less incorrect response.

Test 6b

Target word Sheep



Results of Test 6b

35 listeners (87.5) correctly identified the target word Sheep.

The target word was intelligible to 87.5% listeners.

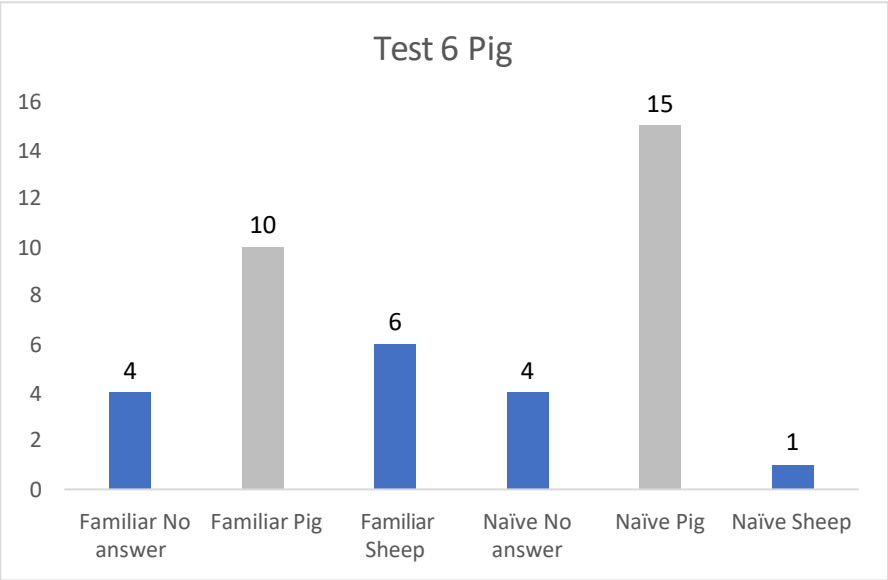
16 familiar listeners correctly identified the target word Sheep.

`19 naïve listeners correctly identified the target word Sheep 1 familiar listener incorrectly identified the word Rat
familiar listener incorrectly identified the word Fox 1 naive listener incorrectly identified the word Pig
familiar listeners No Answers

Naïve listeners achieved 19 correct responses and thus, only 1 incorrect, out performing familiar listeners with only 16 correct responses and 4 incorrect or No Answer responses.

Test 6c

Target word Pig



Results of Test 6c

25 listeners (62.5) correctly identified the target word Pig.

The target word was intelligible to 62.5% of listeners.

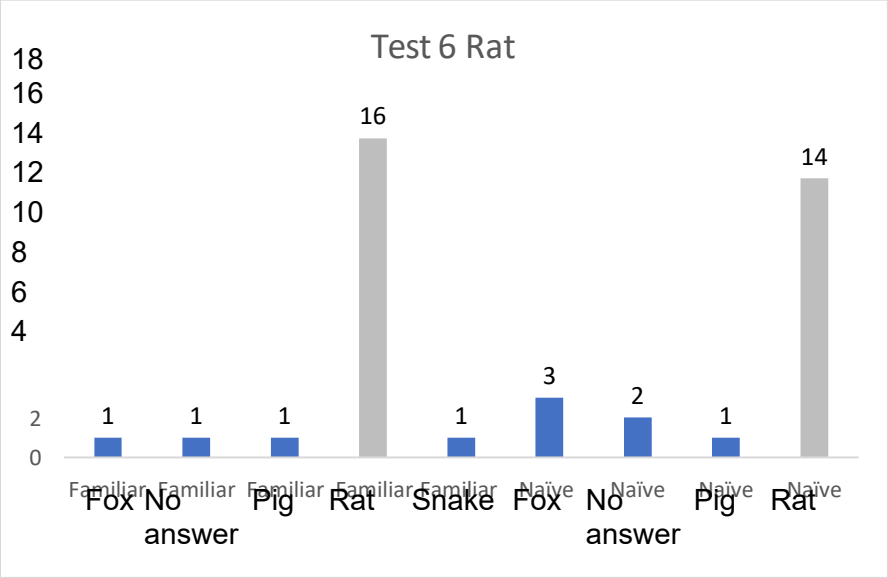
10 familiar listeners correctly identified the target word Pig.

15 naïve listeners correctly identified the target word Pig 6 familiar listeners incorrectly identified the word Sheep 1 naive listener incorrectly identified the word Sheep
4 familiar listeners No Answers 4 naïve listeners No Answers

The number of correct responses are reduced here, achieving the lowest number of correct responses (25) for Test 6. 10 familiar listeners failed to identify the target word, in comparison with 5 naïve listeners.
Familiar listeners made 6 incorrect responses for the word Sheep, while only 1 naïve listeners responded incorrectly with sheep. However, 8 No Answer responses, with 4 naïve and 4 familiar, indicate that this utterance was of limited intelligibility, even within a contextual setting.

Test 6d

Target word Rat



Results for Test 6d

30 listeners correctly identified the target word Rat.

The target word was intelligible to 75% of listeners.

16 familiar listeners correctly identified the target word Rat.

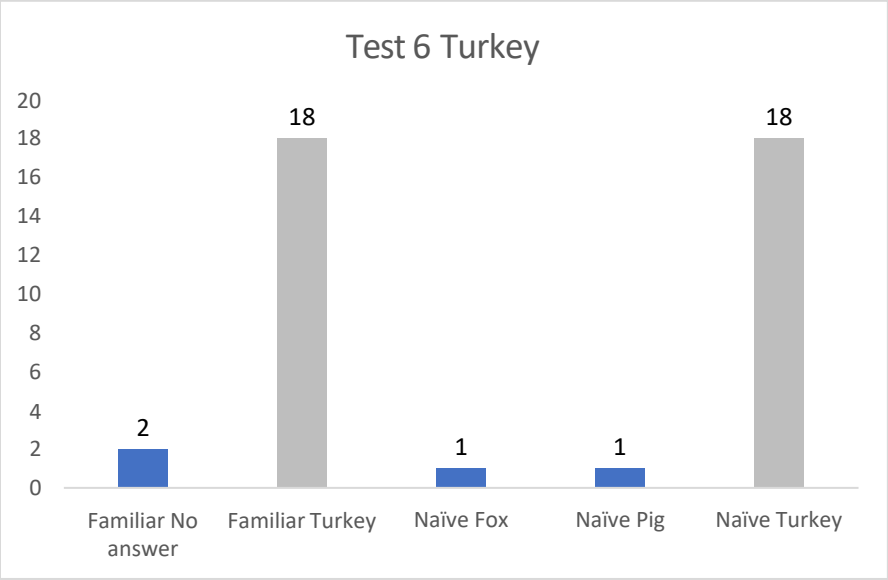
14 naïve listeners correctly identified the target word Rat 1 familiar listener incorrectly identified the word Fox
3 naive listeners incorrectly identified the word Fox 1familiar listener incorrectly identified the word Pig 1 naïve listener incorrectly identified the word Pig
I familiar listener incorrectly identified the word Snake 1 familiar listener No Answers and

2 naïve listeners No Answers

Familiar listeners gave more correct responses (16) and less incorrect responses/ No Answer (3) compared to naive listeners with 14 correct responses and 6 incorrect/No Answer responses.
The scattered error pattern includes No Answer responses, and incorrect responses for Pig (2) and Fox (4)

Test 6e

Target word Turkey



Results for Test 6e

36 listeners correctly identified the target word Turkey.

The target word was intelligible to 90% of listeners.

18 familiar listeners correctly identified the target word Turkey.

18 naïve listeners correctly identified the target word Turkey 1 naive listener incorrectly identified the word Pig
1 naïve listener incorrectly identified the word Fox 2 familiar listeners No Answers

Both familiar and naïve listeners scored equally for correct responses, and equally for incorrect/ No Answer responses.

The influence of semantic context on intelligibility

The influence of semantic class as a contextual clue for SV intelligibility appears to be positive. Results for Test 5 (89.5%) where colour is the semantic class, are higher than for Test 6 (80.5%) where animals are the semantic class, but in both cases percentage intelligibility is in excess of 80%. An additional consideration is the nature of the samples used. SV utterances for the colour samples were elicited by imitation of the researcher's spoken word. Yorkston and Beukelman (1984) report higher intelligibility scores where words are produced in imitation rather than reading tasks or spontaneous speech. The effects of this too may have influenced intelligibility.

Overall outcomes for Test 6

Table A below identifies:

Scores per word
Percentage per word
Total score overall
Total percentage overall

Question 6 Correctly Scored			
Question	Word	Score	Percentage
a	Fox	35	87.5
b	Sheep	35	87.5
c	Pig	25	62.5
d	Rat	30	75
e	Turkey	36	90
	Total	161	
	Max	200	80.5

Table B identifies: for Naïve (N) and Familiar (F) listeners

Overall scores per listener
Overall percentage per listener

Test Six Results				
Listener Number	Familiar Naïve	Correct Words	Out of	Percentage
1	Familiar	5	5	100
2	Naïve	5	5	100
3	Naïve	4	5	80
4	Familiar	5	5	100
5	Naïve	5	5	100
6	Familiar	4	5	80
7	Naïve	5	5	100
8	Naïve	5	5	100
9	Naïve	5	5	100
10	Naïve	1	5	20
11	Naïve	3	5	60
12	Familiar	4	5	80
13	Familiar	4	5	80
14	Naïve	5	5	100
15	Naïve	5	5	100
16	Familiar	5	5	100
17	Naïve	3	5	60
18	Naïve	5	5	100

19	Familiar	5	5	100
20	Familiar	4	5	80
21	Naïve	1	5	20
22	Familiar	5	5	100
23	Naïve	5	5	100
24	Familiar	5	5	100
25	Naïve	5	5	100
26	Naïve	4	5	80
27	Familiar	5	5	100
28	Naïve	5	5	100
29	Familiar	2	5	40
30	Familiar	5	5	100
31	Naïve	5	5	100
32	Naïve	2	5	40
33	Familiar	3	5	60
34	Familiar	3	5	60
35	Familiar	1	5	20
36	Familiar	0	5	0
37	Familiar	5	5	100
38	Naïve	5	5	100
39	Familiar	5	5	100
40	Familiar	3	5	60

T Test Results for Familiar and Naïve for Test 6 were p= 585165

Test 7

Test 7 provided data on listener ability to show perceptual gains with experience of the same SV speaker.

40 listeners heard 6 words to equal 240 words

The correct target words are placed in the grid below

You will hear six words from the list below.

Please write each word in the grid below as you hear it.

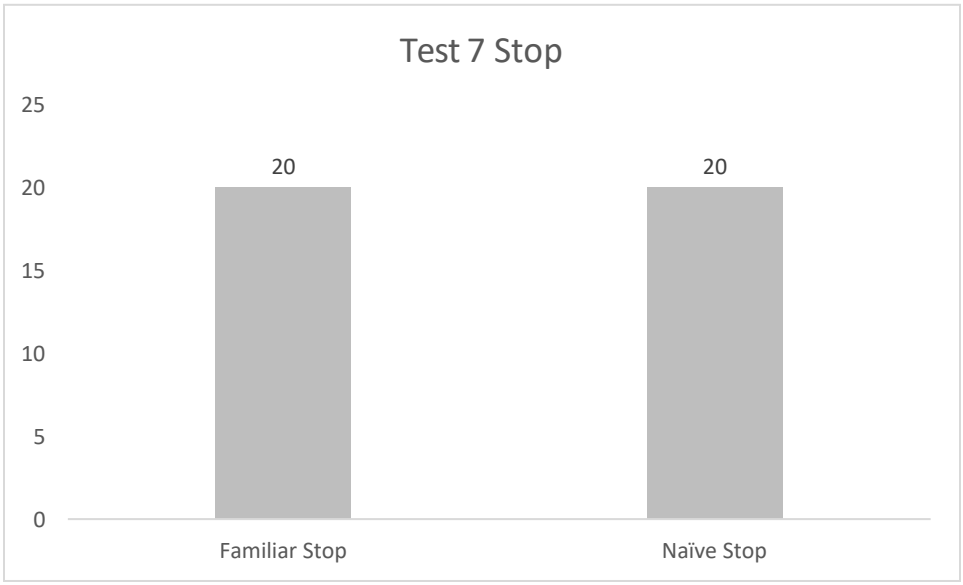
If you do not recognise a word, please leave the box blank. Some words might be repeated.
Happy Stop Myself Listen Dream Sorry

Sample 1	Stop
Sample 2	Happy

Sample 3	Myself
Sample 4	Sorry
Sample 5	Dream
Sample 6	Listen

Test 7a

Target word Stop



Results for Test 7a

40 listeners correctly identified the target word Stop.

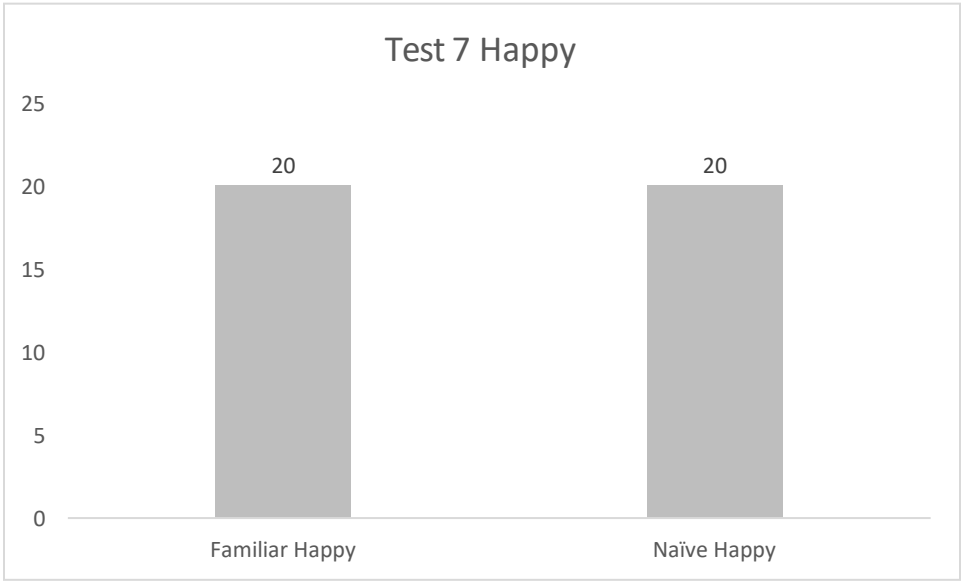
The target word was intelligible to 100% of listeners.

20 familiar listeners correctly identified the target word Stop.

20 naïve listeners correctly identified the target word Stop There was no difference between naïve and familiar listeners.

Test 7b

Target word Happy



Results for Test 7b

40 listeners correctly identified the target word Happy.

The target word was intelligible to 100% of listeners.

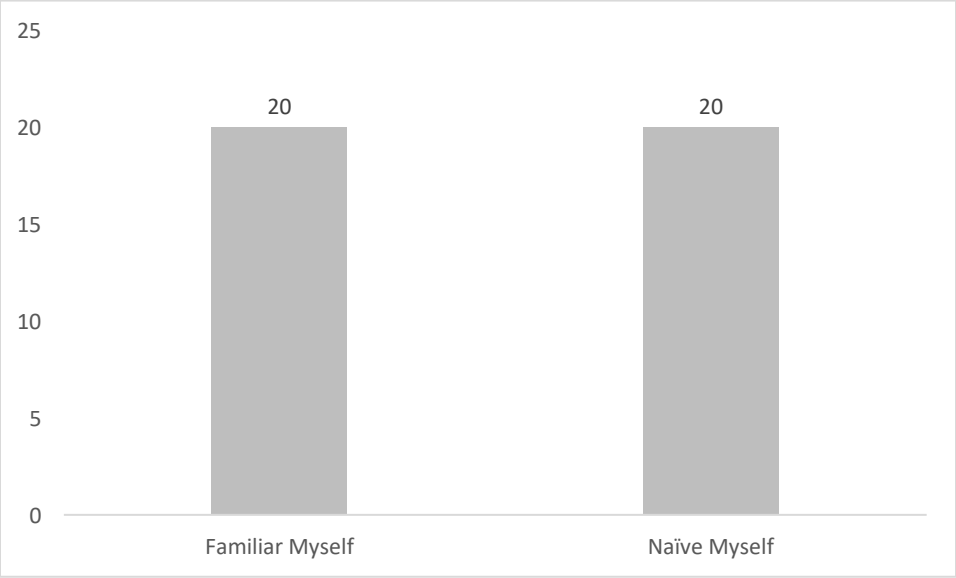
20 familiar listeners correctly identified the target word Happy.

20 naïve listeners correctly identified the target word Happy

There was no difference between naïve and familiar listeners

Test 7c

Target word Myself



Results for Test 7c

40 listeners correctly identified the target word Myself.

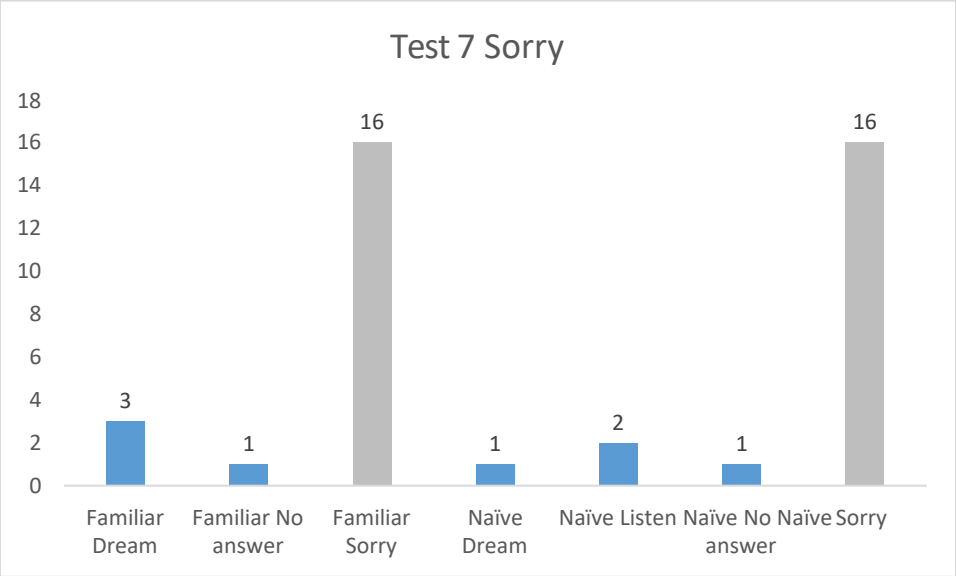
The target word was intelligible to 100% of listeners.

20 familiar listeners correctly identified the target word Myself.

20 naïve listeners correctly identified the target word Myself There was no difference between naïve and familiar listeners

Test 7d

Target word Sorry



Results for Test 7d

32 listeners (80%) correctly identified the target word Sorry.

The target word was intelligible to 82% of listeners.

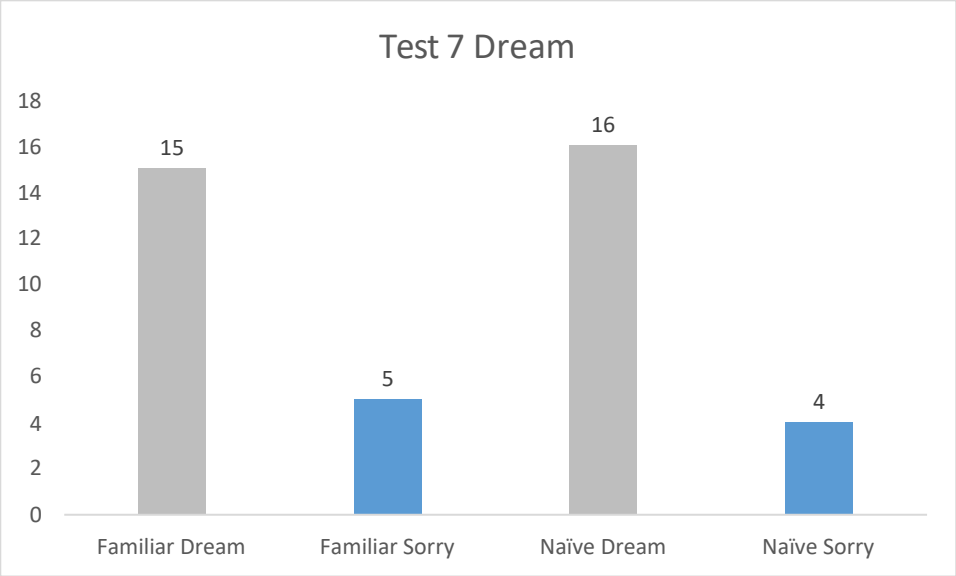
16 familiar listeners correctly identified the target word Sorry.

16 naïve listeners correctly identified the target word Sorry 3 familiar listeners incorrectly identified the word Dream
1 naive listener incorrectly identified the word Dream 2 naïve listeners incorrectly identified the word Listen 1 familiar listener No Answer
1 naive listener No Answer

Familiar and naïve listeners scored equally for correct responses (16 and 16) and an equal number of incorrect responses (4 each) and No Answer (1 each)

Test 7e

Target word Dream



Results for Test 7e

31 (77.5) listeners correctly identified the target word Dream.

The target word was intelligible to 77.5% of listeners.

familiar listeners correctly identified the target word Dream.

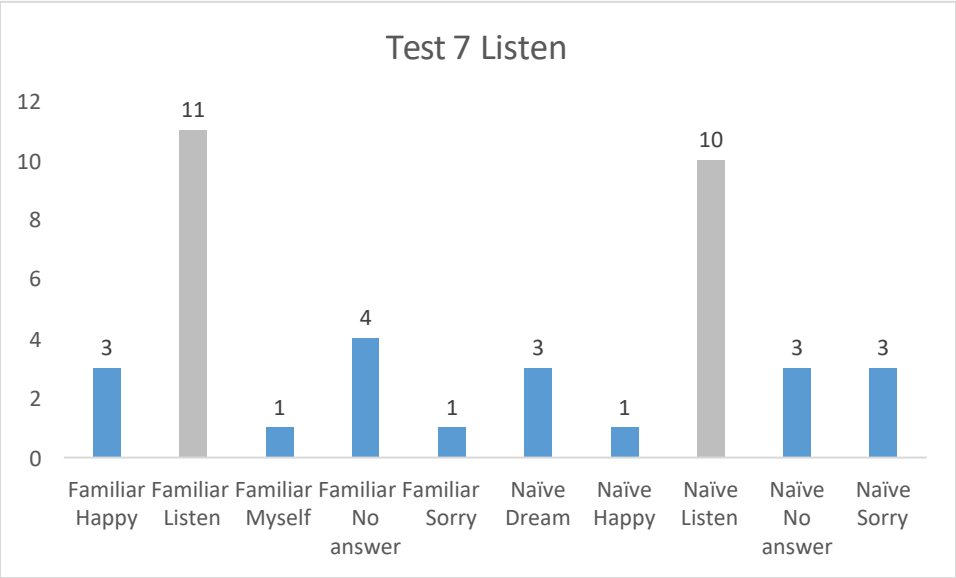
naïve listeners correctly identified the target word Dream 5 familiar listeners incorrectly identified the word Sorry
4 naive listeners incorrectly identified the word Sorry

Naïve listeners performed better for Dream, having 16 correct responses compared to 15 correct responses by familiar listeners. Naive listeners also had fewer errors (4) than familiar listeners (5)

Incorrect responses by both naïve and familiar listeners identified Sorry, suggesting that some feature of the word Dream bore similarity to the word Sorry.

Test 7f

Target word Listen



Results for Test 7f

Target word Listen

21 listeners (52.5%) correctly identified the target word Listen.

The target word was intelligible to 52.5.% of listeners.

11 familiar listeners correctly identified the target word Listen.

10 naïve listeners correctly identified the target word Listen 3 familiar listeners incorrectly identified the word Happy
1 naive listener incorrectly identified the word Happy

1 familiar listener incorrectly identified the word Myself 1 familiar listener incorrectly identified the word Sorry 3 naive listeners incorrectly identified the word Sorry 3 naive listeners incorrectly identified the word Dream 4 familiar listeners No Answer
3 naïve listeners No Answer

The score for correct responses for Listen reduced noticeably in comparison with the previous options in Test 7 a-f, and the scattered error pattern suggests that many listeners, both familiar and naïve were perceptually challenged. 7 listeners responded with No Answer (3 naïve, 4 familiar) while 12 listeners responded incorrectly, choosing all words included in the closed choice, except STOP.

The influence of experience on perceptual gains by listeners (all words by the same participant.)
Initially, listeners scored highly on this test, achieving 100% correct responses for the first three words. However, scores decreased as the test progressed, with the last word obtaining the lowest score, suggesting that listeners did not achieve perceptual gains with experience of the same SV speaker.
Overall outcomes for Test 7

Table A below identifies:

Scores per word
Percentage per word
Total score overall
Total percentage overall

Question 7 Correctly Scored			
Question	Word	Score	Percentage
a	Stop	40	100
b	Happy	40	100
c	Myself	40	100
d	Sorry	32	80
e	Dream	31	77.5
f	Listen	21	52.5
	Total	204	
	Max	240	85

Table B identifies:

Naïve and Familiar listeners
Overall scores per listener

Overall percentage per listener

Test Seven Results				
Listener Number	Familiar Naïve	Correct Words	Out of	Percentage
1	Familiar	5	6	83
2	Naïve	6	6	100
3	Naïve	4	6	67
4	Familiar	4	6	67
5	Naïve	5	6	83
6	Familiar	4	6	67
7	Naïve	6	6	100
8	Naïve	6	6	100
9	Naïve	5	6	83
10	Naïve	6	6	100
11	Naïve	6	6	100
12	Familiar	6	6	100
13	Familiar	5	6	83
14	Naïve	3	6	50
15	Naïve	6	6	100
16	Familiar	5	6	83
17	Naïve	5	6	83
18	Naïve	4	6	67
19	Familiar	6	6	100
20	Familiar	4	6	67
21	Naïve	5	6	83
22	Familiar	5	6	83
23	Naïve	4	6	67
24	Familiar	6	6	100
25	Naïve	6	6	100
26	Naïve	4	6	67
27	Familiar	6	6	100
28	Naïve	5	6	83
29	Familiar	6	6	100
30	Familiar	4	6	67
31	Naïve	5	6	83
32	Naïve	5	6	83
33	Familiar	6	6	100
34	Familiar	4	6	67
35	Familiar	6	6	100
36	Familiar	6	6	100
37	Familiar	5	6	83
38	Naïve	6	6	100
39	Familiar	5	6	83
40	Familiar	4	6	67

T 87 T Test results for Test 7 Familiar and Naïve were p= 1

Overall results for closed tests 1-7

At completion of Test 7, overall results for all closed tests were computed. Percentage intelligibility for all tests, and overall was as follows:

Comparison of test scores overall.

Test no	Overall Test Score %
Test 1	61.5
Test 2	91.5
Test 3	90.3
Test 4	66.7
Test 5	89.5
Test 6	80.5
Test 7	85
	80.71

Further results were compiled as tables to show outcomes and comparisons between all closed tests as below.

Correctly Selected Words out of 1680		
Correct	1370	0.82
Incorrect	310	0.18

Comparison of words overall for closed tests 1-7

Highest Scoring Words			
Test	Word	Score	Percentage
Test 2 S1	Yes	40	100.0
Test 3 3	Purple	40	100.0
Test 3 4	Yes	40	100.0
Test 3 5	Better	40	100.0
Test 4 S3	Christmas	40	100.0
Test 7 S1	Stop	40	100.0
Test 7 S2	Happy	40	100.0
Test 7 S3	Myself	40	100.0

Lowest Scoring words			
Test	Word	Score	Percentage
Test 1b	Dad	24	60.0
Test 4 S1	Home	24	60.0
Test 4 S6	Private	21	52.5
Test 7 S6	Listen	21	52.5
Test 4 S2	Father	17	42.5
Test 1d	Perfect	15	37.5
Test 1e	Lucky	14	35.0

Correctly/ incorrectly identified words/ number of words per listener per closed test

All Results										
Number	F/N	T1 /5	T2/5	T3/10	T4/6	T5/5	T6/5	T7/6	Overall/42	Percentage
1	F	3	5	10	6	3	5	5	37	88.1
2	N	4	5	9	4	5	5	6	38	90.5
3	N	4	4	10	4	5	4	4	35	83.3
4	F	3	5	10	3	5	5	4	35	83.3
5	N	4	5	9	4	5	5	5	37	88.1
6	F	3	3	10	2	5	4	4	31	73.8
7	N	4	4	9	5	2	5	6	35	83.3
8	N	2	5	9	4	5	5	6	36	85.7
9	N	3	3	9	5	5	5	5	35	83.3
10	N	2	5	8	4	3	1	6	29	69.0
11	N	3	2	9	2	4	3	6	29	69.0
12	F	4	5	9	2	5	4	6	35	83.3
13	F	4	5	9	3	5	4	5	35	83.3
14	N	3	5	9	6	5	5	3	36	85.7
15	N	4	5	8	6	5	5	6	39	92.9
16	F	2	5	10	4	5	5	5	36	85.7
17	N	2	3	9	4	5	3	5	31	73.8
18	N	3	5	9	4	5	5	4	35	83.3
19	F	4	5	9	4	5	5	6	38	90.5
20	F	5	5	10	2	5	4	4	35	83.3

21	N	1	5	9	5	5	1	5	31	73.8
22	F	3	5	9	2	3	5	5	32	76.2
23	N	4	5	8	5	5	5	4	36	85.7
24	F	4	5	9	4	5	5	6	38	90.5
25	N	3	5	8	5	5	5	6	37	88.1
26	N	3	5	9	3	4	4	4	32	76.2
27	F	3	5	10	4	5	5	6	38	90.5
28	N	2	4	10	4	5	5	5	35	83.3
29	F	2	3	10	5	3	2	6	31	73.8
30	F	4	5	8	2	5	5	4	33	78.6
31	N	3	5	9	4	5	5	5	36	85.7
32	N	1	3	10	4	4	2	5	29	69.0
33	F	4	5	9	4	3	3	6	34	81.0
34	F	3	5	10	4	5	3	4	34	81.0
35	F	4	5	8	4	4	1	6	32	76.2
36	F	2	5	8	6	4	0	6	31	73.8
37	F	1	5	9	5	5	5	5	35	83.3
38	N	2	4	6	3	3	5	6	29	69.0
39	F	3	5	9	6	4	5	5	37	88.1
40	F	4	5	9	3	5	3	4	33	78.6

Percentage intelligibility per listener per test

Listener	Test 1	Test 2	Test 3	Test 4	Test 5	Tests 6	Test 7	Mean

1	60.0	100.0	100.0	100.0	60.0	100.0	83.3	86.2
2	80.0	100.0	90.0	66.7	100.0	100.0	100.0	91.0
3	80.0	80.0	100.0	66.7	100.0	80.0	66.7	81.9
4	60.0	100.0	100.0	50.0	100.0	100.0	66.7	82.4
5	80.0	100.0	90.0	66.7	100.0	100.0	83.3	88.6
6	60.0	60.0	100.0	33.3	100.0	80.0	66.7	71.4
7	80.0	80.0	90.0	83.3	40.0	100.0	100.0	81.9
8	40.0	100.0	90.0	66.7	100.0	100.0	100.0	85.2
9	60.0	60.0	90.0	83.3	100.0	100.0	83.3	82.4
10	40.0	100.0	80.0	66.7	60.0	20.0	100.0	66.7
11	60.0	40.0	90.0	33.3	80.0	60.0	100.0	66.2
12	80.0	100.0	90.0	33.3	100.0	80.0	100.0	83.3
13	80.0	100.0	90.0	50.0	100.0	80.0	83.3	83.3
14	60.0	100.0	90.0	100.0	100.0	100.0	50.0	85.7
15	80.0	100.0	80.0	100.0	100.0	100.0	100.0	94.3
16	40.0	100.0	100.0	66.7	100.0	100.0	83.3	84.3
17	40.0	60.0	90.0	66.7	100.0	60.0	83.3	71.4
18	60.0	100.0	90.0	66.7	100.0	100.0	66.7	83.3
19	80.0	100.0	90.0	66.7	100.0	100.0	100.0	91.0
20	100.0	100.0	100.0	33.3	100.0	80.0	66.7	82.9
21	20.0	100.0	90.0	83.3	100.0	20.0	83.3	71.0
22	60.0	100.0	90.0	33.3	60.0	100.0	83.3	75.2
23	80.0	100.0	80.0	83.3	100.0	100.0	66.7	87.1
24	80.0	100.0	90.0	66.7	100.0	100.0	100.0	91.0

25	60.0	100.0	80.0	83.3	100.0	100.0	100.0	89.0
26	60.0	100.0	90.0	50.0	80.0	80.0	66.7	75.2
27	60.0	100.0	100.0	66.7	100.0	100.0	100.0	89.5
28	40.0	80.0	100.0	66.7	100.0	100.0	83.3	81.4
29	40.0	60.0	100.0	83.3	60.0	40.0	100.0	69.0
30	80.0	100.0	80.0	33.3	100.0	100.0	66.7	80.0
31	60.0	100.0	90.0	66.7	100.0	100.0	83.3	85.7
32	20.0	60.0	100.0	66.7	80.0	40.0	83.3	64.3
33	80.0	100.0	90.0	66.7	60.0	60.0	100.0	79.5
34	60.0	100.0	100.0	66.7	100.0	60.0	66.7	79.0
35	80.0	100.0	80.0	66.7	80.0	20.0	100.0	75.2
36	40.0	100.0	80.0	100.0	80.0	0.0	100.0	71.4
37	20.0	100.0	90.0	83.3	100.0	100.0	83.3	82.4
38	40.0	80.0	60.0	50.0	60.0	100.0	100.0	70.0
39	60.0	100.0	90.0	100.0	80.0	100.0	83.3	87.6
40	80.0	100.0	90.0	50.0	100.0	60.0	66.7	78.1

Test no	Overall Test Score %
Test 1	61.5
Test 2	91.5
Test 3	90.3
Test 4	66.7

Test 5	89.5
Test 6	80.5
Test 7	85
	80.71

Item scores (decreasing) Test 1 – 7 in descending order

Test	Word	Score	Percentage
Test 2 S1	Yes	40	100.0
Test 3.3	Purple	40	100.0
Test 3.4	Yes	40	100.0
Test 3.5	Better	40	100.0
Test4.S.3	Christmas	40	100.0
Test7 S.1	Stop	40	100.0
Test7 S.2	Happy	40	100.0
Test7 S.3	Myself	40	100.0
Test3 2	Medicine	39	97.5
Test5 S.1	Blue	39	97.5
Test5 S.3	Red	39	97.5
Test2 S.2	Bus	38	95.0
Test3 9	Summer	38	95.0
Test5 S.2	Yellow	38	95.0

Test3 1	Budgie	37	92.5
Test3 10	Brilliant	37	92.5
Test2 S.5	Mum	36	90.0
Test6 S.5	Turkey	36	90.0
Test1.a	Speak	35	87.5
Test2 S.4	Dad	35	87.5
Test5 S.5	Purple	35	87.5
Test6 S.1	Fox	35	87.5
Test6 S.2	Sheep	35	87.5
Test 1.c	Something	34	85.0
Test2 S.6	sit	34	85.0
Test 3 6	Said	33	82.5
Test 3 7	Fabulous	32	80.0
Test7 S.4	Sorry	32	80.0
Test4 S.5	Care	31	77.5
Test7 S.5	Dream	31	77.5
Test6 S.4	Rat	30	75.0
Test5 S.4	Orange	28	70.0
Test4 S.4	Super	27	67.5
Test3 8	Right	25	62.5
Test6 S.3	Pig	25	62.5
Test 1 b	Dad	24	60.0
Test4 S.1	Home	24	60.0
Test4 S.6	Private	21	52.5

Test7 S.6	Listen	21	52.5
Test4 S.2	Father	17	42.5
Test 1 d	Perfect	15	37.5
Test 1 e	Lucky	14	35.0

Ranked order of tests

Test	Score
Test 2	91.5
Test 3	90.3
Test 5	89.5
Test 7	85.0
Tests 6	80.5
Test 4	66.7
Test 1	61.0

Ranked order of words

Test	Word	Score	Percentage
Test 3 5	Better	40	100.0

Test 4 S3	Christmas	40	100.0
Test 7 S2	Happy	40	100.0
Test 7 S3	Myself	40	100.0
Test 3 3	Purple	40	100.0
Test 7 S1	Stop	40	100.0
Test 2 S1	Yes	40	100.0
Test 3 4	Yes	40	100.0
Test 5 S1	Blue	39	97.5
Test 3 2	Medicine	39	97.5
Test 5 S3	Red	39	97.5
Test 2 S2	Bus	38	95.0
Test 3 9	Summer	38	95.0
Test 5 S2	Yellow	38	95.0
Test 3 10	Brilliant	37	92.5
Test 3 1	Budgie	37	92.5
Test 2 S5	Mum	36	90.0
Test 6 S5	Turkey	36	90.0
Test 2 S4	Dad	35	87.5
Test 6 S1	Fox	35	87.5
Test 5 S5	Purple	35	87.5
Test 6 S2	Sheep	35	87.5
Test 1a	Speak	35	87.5
Test 2 S6	sit	34	85.0
Test 1c	Something	34	85.0

Test 3 6	Said	33	82.5
Test 3 7	Fabulous	32	80.0
Test 7 S4	Sorry	32	80.0
Test 4 S5	Care	31	77.5
Test 7 S5	Dream	31	77.5
Test 6 S4	Rat	30	75.0
Test 5 S4	Orange	28	70.0
Test 4 S4	Super	27	67.5
Test 6 S3	Pig	25	62.5
Test 3 8	Right	25	62.5
Test 1b	Dad	24	60.0
Test 4 S1	Home	24	60.0
Test 7 S6	Listen	21	52.5
Test 4 S6	Private	21	52.5
Test 4 S2	Father	17	42.5
Test 1d	Perfect	15	37.5
Test 1e	Lucky	14	35.0

Mean listener scores for closed tests.

The mean of individual listener scores and percentages was compared with the overall scores and percentages for all closed tests to check variation across results. For Listener 1 for example, the mean across all tests is 86.2% (as the average of all

percentages) for a score of 37 correct words out of a maximum of 42 - a percentage score of 88.1%. As seen in the table below, the variation between results was insignificant.

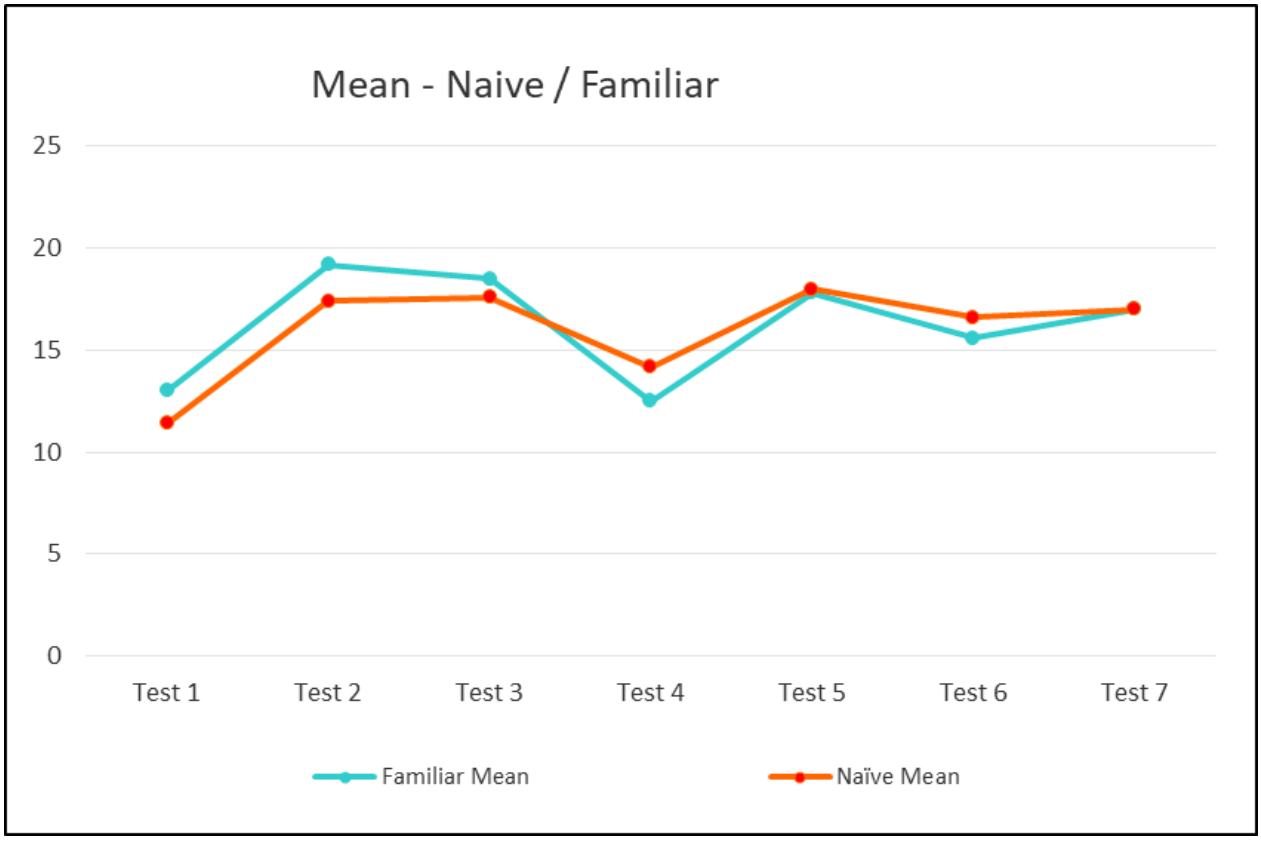
Listener	Mean	Percentage	Variation
1	86.2	88.1	-1.9
2	91.0	90.5	0.5
3	81.9	83.3	-1.4
4	82.4	83.3	-1.0
5	88.6	88.1	0.5
6	71.4	73.8	-2.4
7	81.9	83.3	-1.4
8	85.2	85.7	-0.5
9	82.4	83.3	-1.0
10	66.7	69.0	-2.4
11	66.2	69.0	-2.9
12	83.3	83.3	0.0
13	83.3	83.3	0.0
14	85.7	85.7	0.0
15	94.3	92.9	1.4
16	84.3	85.7	-1.4
17	71.4	73.8	-2.4
18	83.3	83.3	0.0

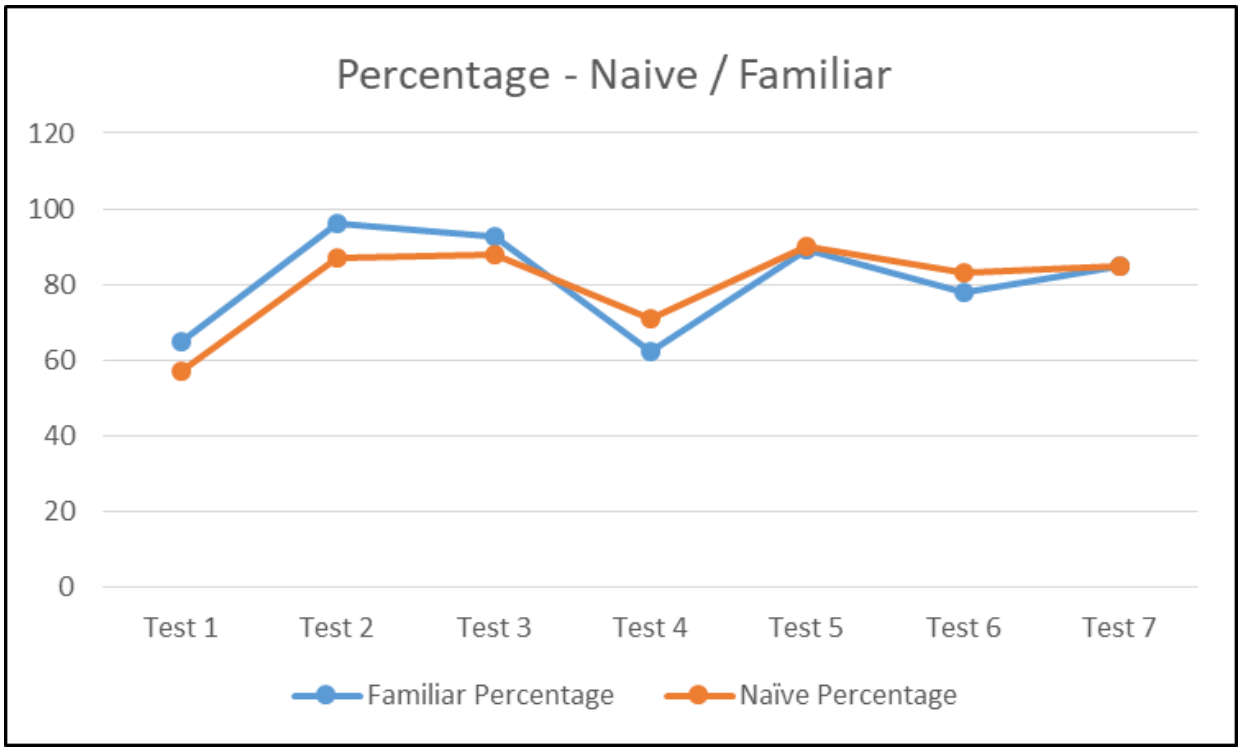
19	91.0	90.5	0.5
20	82.9	83.3	-0.5
21	71.0	73.8	-2.9
22	75.2	76.2	-1.0
23	87.1	85.7	1.4
24	91.0	90.5	0.5
25	89.0	88.1	1.0
26	75.2	76.2	-1.0
27	89.5	90.5	-1.0
28	81.4	83.3	-1.9
29	69.0	73.8	-4.8
30	80.0	78.6	1.4
31	85.7	85.7	0.0
32	64.3	69.0	-4.8
33	79.5	81.0	-1.4
34	79.0	81.0	-1.9
35	75.2	76.2	-1.0
36	71.4	73.8	-2.4
37	82.4	83.3	-1.0
38	70.0	69.0	1.0
39	87.6	88.1	-0.5
40	78.1	78.6	-0.5
Total	80.6	81.5	-0.9

Results for naïve and familiar listeners

The influence of familiarity on perception of SV words in closed tests.

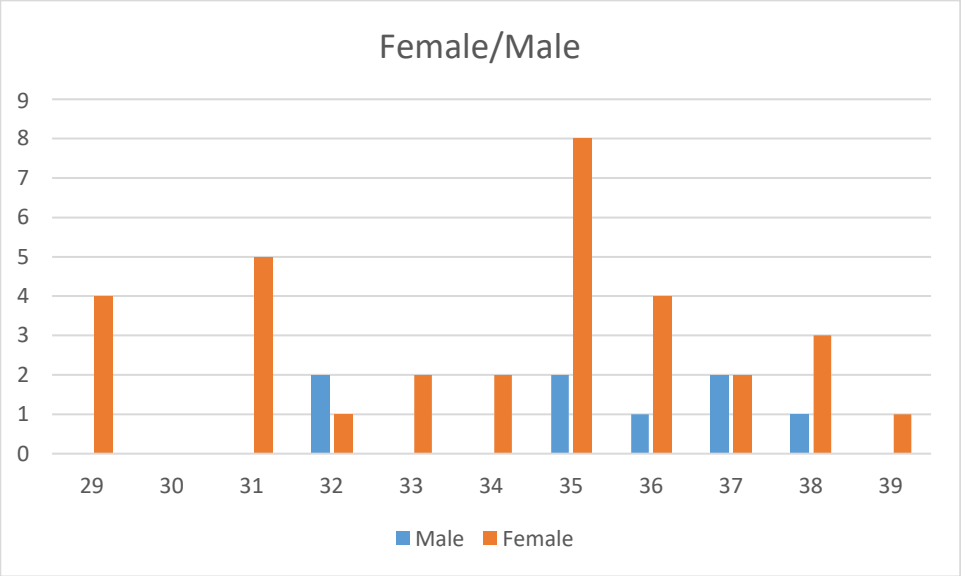
Comparative scores for naïve and familiar listeners were calculated for percentage and mean scores for each test. As seen in the graphs below, the difference was insignificant for closed tests.





Gender - for closed tests

Consideration was given to the effects of gender upon listener perception but due to the imbalance in the listener set (8 male and 32 female) this was computed for later reference, rather than viewed as integral to the study. The graph below illustrates the scores for closer analysis and the mean score for males and females is represented in Table 1 ???



The table presents the calculated/total scores for “team male” divided by 8 men. Similarly, the female score is added as a total and divided by 32. The result is open to interpretation as women score 81% and fewer men score 84% percentage mean. Depending on interpretation of results, women seem to be better as they have a consistently high score, but less men achieved a higher average mean. At this point in the study, there is insufficient information and further research needed with a gender balance for more precise and exact information.
NB. The gender imbalance in the study reflected the gender imbalance in the educational establishments attended by participants. Familiar listeners were, of necessity drawn from staff/carers and parents, where fewer men were available.

Results	Male	Female
29	0	4

30	0	0
31	0	5
32	2	1
33	0	2
34	0	2
35	2	8
36	1	4
37	2	2
38	1	3
39	0	1
Total	8	32
Overall Score	282	1088
Mean Score	35.25	34

Summary of data for closed tests 1-7

Intelligibility scores (80.71%) for the closed listener tests identified the ability of listeners (both naïve and familiar) to extract sufficient information from the word samples to understand, in the right conditions, individuals normally people considered to be pre-verbal and pre-linguistic. The expectation that conversational partners would consider the participants to be anarthric was confounded. A comparable score on a dysarthric intelligibility test would be considered moderately dysarthric (AIDS test.)

Open tests

Open tests of listener intelligibility were comprised of 3 open tests: Test 8, Test 8A and Test 9
Listeners wererequired to orthographically transcribe all words included in each sample.
There were 77 words in total, comprising 34 utterances of word length from 1 -5. Thus, 40 listeners heard 77 words to equal 3080.

Scoring

Intelligibility scoring in open tests, as with closed tests, allocated 1 for the correct transcription of a word and 0 for the incorrect transcription of a word. As with the closed tests above, contractions (can't , I'm .) were counted as 2.
The total number of words correctly identified provided the measure of percentage intelligibility for open sentences in Tests 8, Test 8a and Test 9.

Test 8

Test 8 was the first open test, with a word pool of 8 SV words. 7 questions asked of participants by the researcher set the specific context for the response set of:
8 responses, of which:

6 were 1 word utterances and
1 was a 2 word utterance.
Thus, Test 8 required transcription of 8 words by 40 listeners to total 320 words

Test 8 set target words in context

Rational for Test 8

Test 8 was the first open test. Participant responses had been elicited in Question and Answer sessions therefore setting responses in context.
Unlike the closed tests, where listeners identified the stimulus from a selection of given responses, the specific context in Test 8, offered clearly predictable responses. This was intended to measure listener intelligibility in situations where the normal partner offers restricted choices to his/her SV partner. Situations such as limited choice making– 'Do you want orange squash or hot chocolate?' – enabled the response to be anticipated. For individuals with very restricted communication options, the opportunity to make their own decision, even within such a limited choice, had benefits to both participant and listener. Anticipated responses facilitate intelligibility as listeners 'predicted' successfully from the limited responses available to the participant, potentially improving their own listener competence, while participants become active partners in previously unavailable communicative dialogues.
In order to ensure that listeners understood the anticipated response, listeners were clearly instructed to transcribe the response only if it could be perceived. A response should not be transcribed unless actually heard and understood. In addition, listeners were not informed whether responses would be correct so even where listeners would be clearly expected to know the answer, the participant's response could not be guaranteed.

Test 8

Test 8 provided data on listener intelligibility for predictable open responses.

Test 8 Questions

Listen to the questions, then write down the answer you think you hear. Test 8 answers are included below.

Can you tell me which country you live in?

England

Can you tell me the name of the previous Prime Minister? David Cameron

Can you tell me the name of the Queen of England? Elizabeth

What’s the capital of France? Paris

Can you tell me the name of America’s capital city?

Washington

How many pennies in a one pound coin? Hundred

Can you tell me what day it will be tomorrow?

Thursday

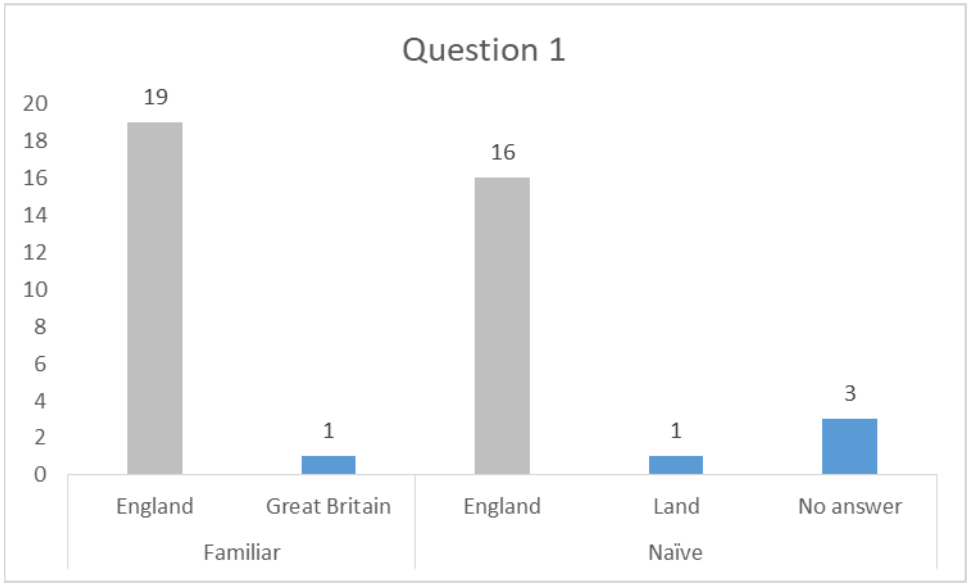
Results for Test 8

The overall percentage for Test 8 at 70.3% is high. The influence of the predictability of the responses is uncertain, as the error patterns below suggest that listeners did hear responses, rather than predict them. If this is the case, the outcomes are very positive.
The tri-syllabic word Washington achieved the lowest score at 37.5% but Elizabeth, also tri-syllabic achieved 87.5% intelligibility.

As seen in the graphs below, the error pattern shows scatter for a number of No Answer responses, as well as a number of incorrect responses, indicating that listeners did adhere to the instruction to transcribe only what they heard and understood. Across all questions, listeners failed to complete answers that they should know , 12 listeners failing to transcribe the answer to ‘How many pennies in a one pound coin?' demonstrating their perceptual failure to perceive the obvious and

well known target word. The last sentence response required ‘Thursday,’ (‘What day will it be tomorrow?) with a 1/7 chance of transcribing correctly due to semantic context, but 6 listeners failed to identify the target word.

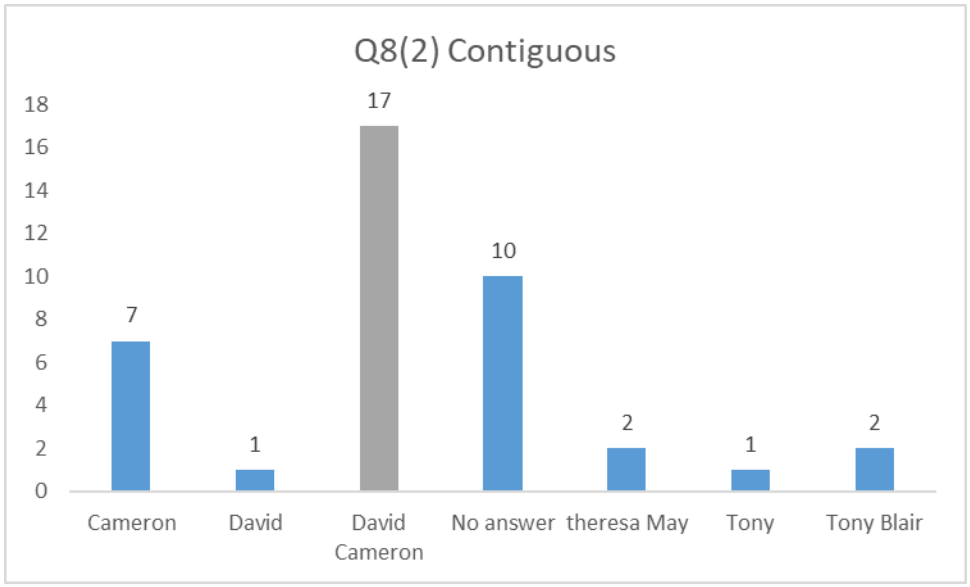
Results: Question 8.1.

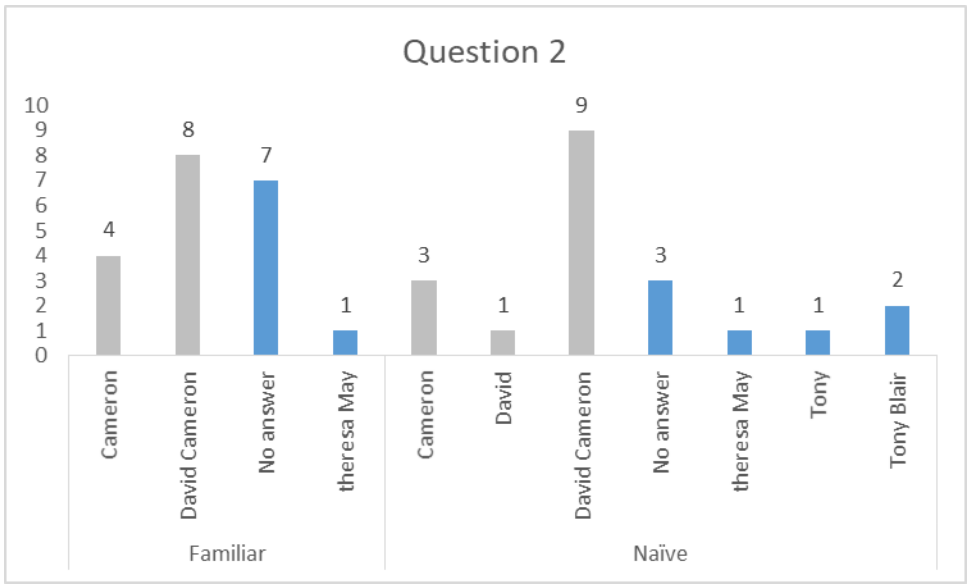


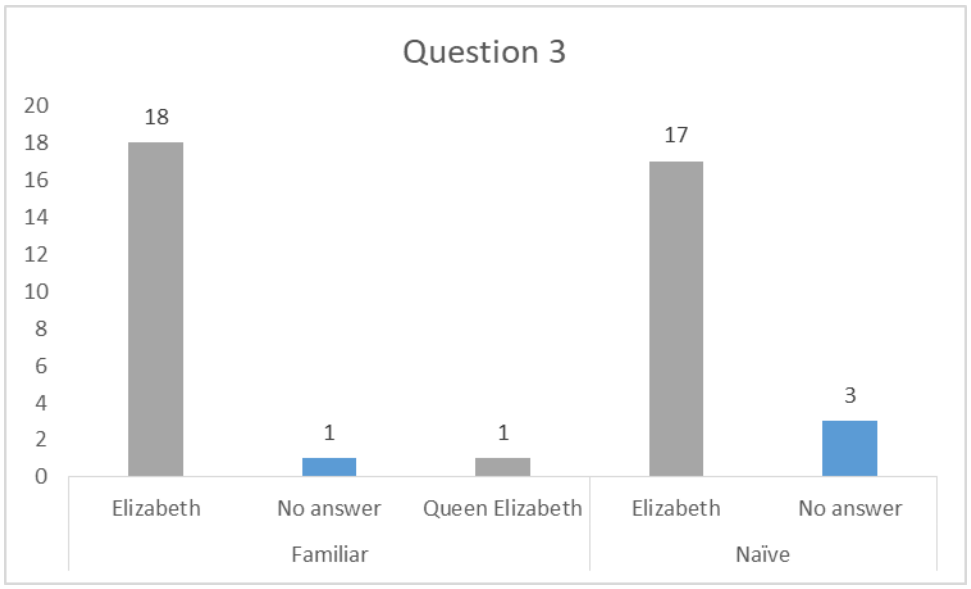
Question 2

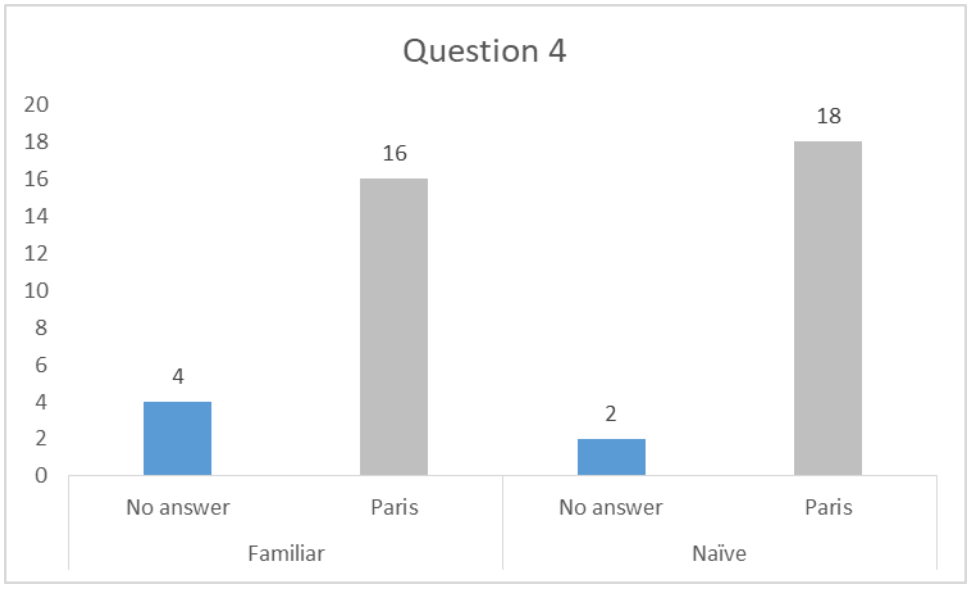
The correct response for Question 2 in Test 8 was David Cameron, the first contiguous words encountered by listeners. Examination of the overall results, shown in the graph below, show scatter across both words, with the correct version of David and Cameron

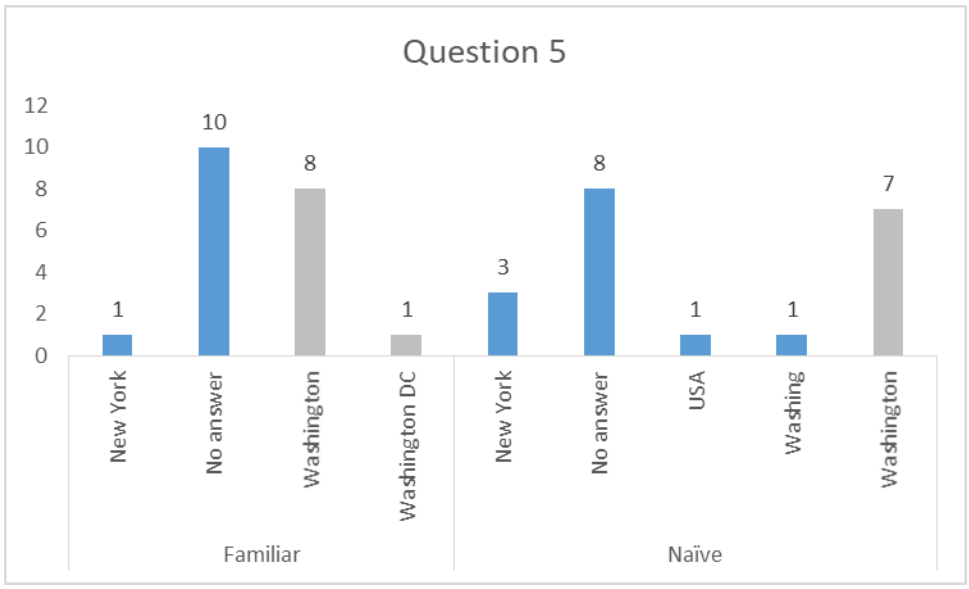
achieving 52.5.%. The failure of some (47.5%) listeners to perceive both words reinforces the understanding that listeners did indeed transcribe only the words heard but raises the issue of the influence of contiguous words on intelligibility of the sample. However, the difference in scores is small, and further data was needed to explore this. The difference between naive and familiar listeners was insignificant

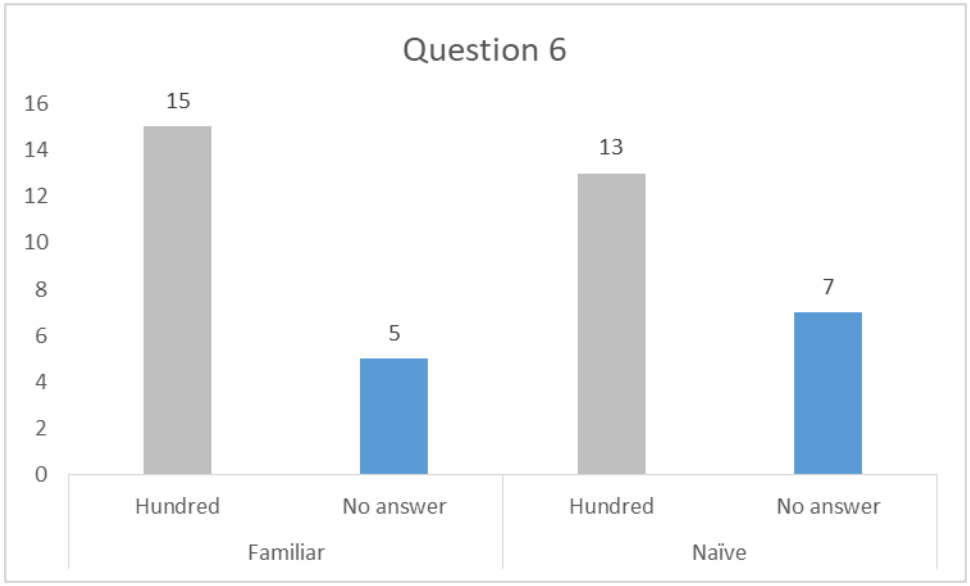


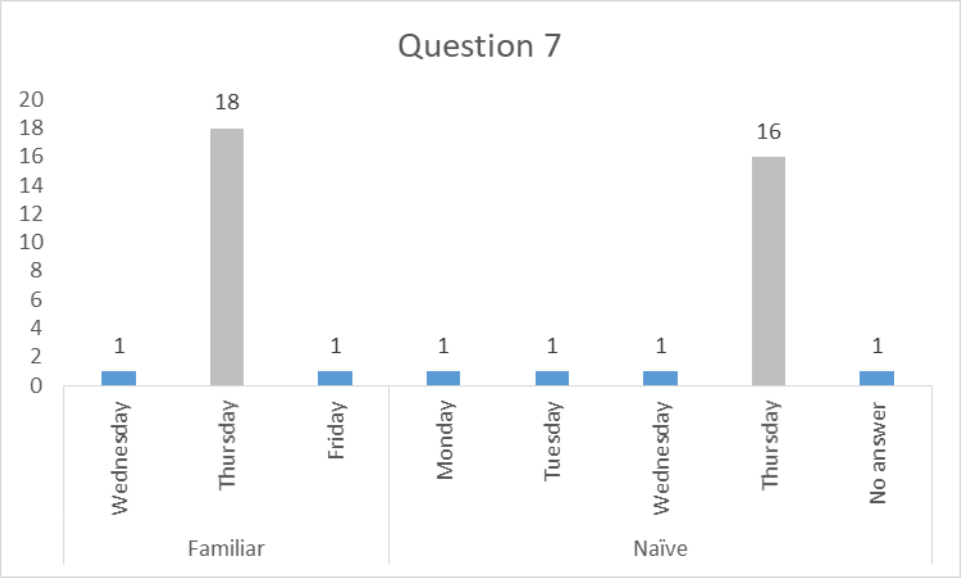



Question 3
20
18
16
14
12
10
8
6
4
2
0
18
1
1
17
3
Elizabeth
No answer
Queen Elizabeth
Elizabeth
No answer
Familiar
Naïve


Question 4
20
18
16
14
12
10
8
6
4
2
0
4
16
2
18
No answer
Paris
No answer
Paris
Familiar
Naïve


Question 5
12
10
8
6
4
2
0
1
10
8
1
3
8
1
1
7
New York
No answer
Washington
Washington DC
New York
No answer
USA
Washing
Washington
Familiar
Naïve


Question 6
16
14
12
10
8
6
4
2
0
15
5
13
7
Hundred
No answer
Hundred
No answer
Familiar
Naïve



The total number of words correctly identified provided the measure of percentage intelligibility for open sentences in Test 8.

Results for Test 8

Question 8 Correctly Scored			
Question	Word	Score	Percentage
a	England	35	87.5
b	David Cameron	42	52.5
c	Elizabeth	36	90
d	Paris	34	85
e	Washington	16	40

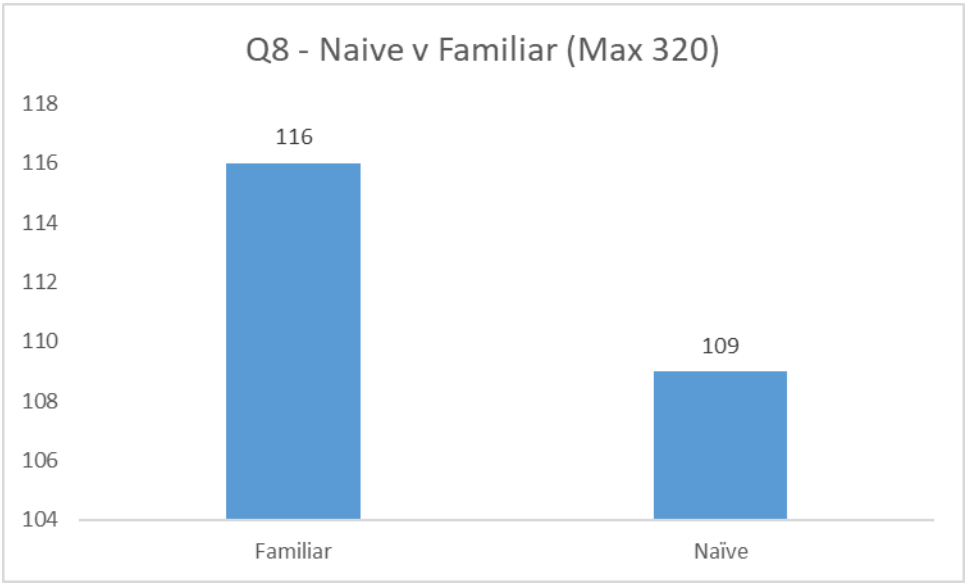
f	hundred	28	70
g	Thursday	34	85
	Total	225	
	Max	320	70.3

Test Eight Results				
Listener Number	Familiar Naïve	Correct Word	Out of	Percentage
1	Familiar	7	8	88
2	Naïve	4	8	50
3	Naïve	7	8	88
4	Familiar	8	8	100
5	Naïve	7	8	88
6	Familiar	7	8	88
7	Naïve	5	8	63
8	Naïve	7	8	88
9	Naïve	6	8	75
10	Naïve	3	8	38
11	Naïve	4	8	50
12	Familiar	6	8	75
13	Familiar	4	8	50
14	Naïve	7	8	88
15	Naïve	7	8	88
16	Familiar	5	8	63
17	Naïve	5	8	63
18	Naïve	5	8	63
19	Familiar	8	8	100
20	Familiar	7	8	88
21	Naïve	5	8	63
22	Familiar	5	8	63
23	Naïve	6	8	75
24	Familiar	8	8	100
25	Naïve	4	8	50
26	Naïve	6	8	75
27	Familiar	7	8	88
28	Naïve	5	8	63
29	Familiar	4	8	50
30	Familiar	6	8	75
31	Naïve	6	8	75
32	Naïve	6	8	75
33	Familiar	2	8	25
34	Familiar	5	8	63
35	Familiar	8	8	100
36	Familiar	5	8	63
37	Familiar	5	8	63
38	Naïve	4	8	50
39	Familiar	6	8	75
40	Familiar	3	8	38

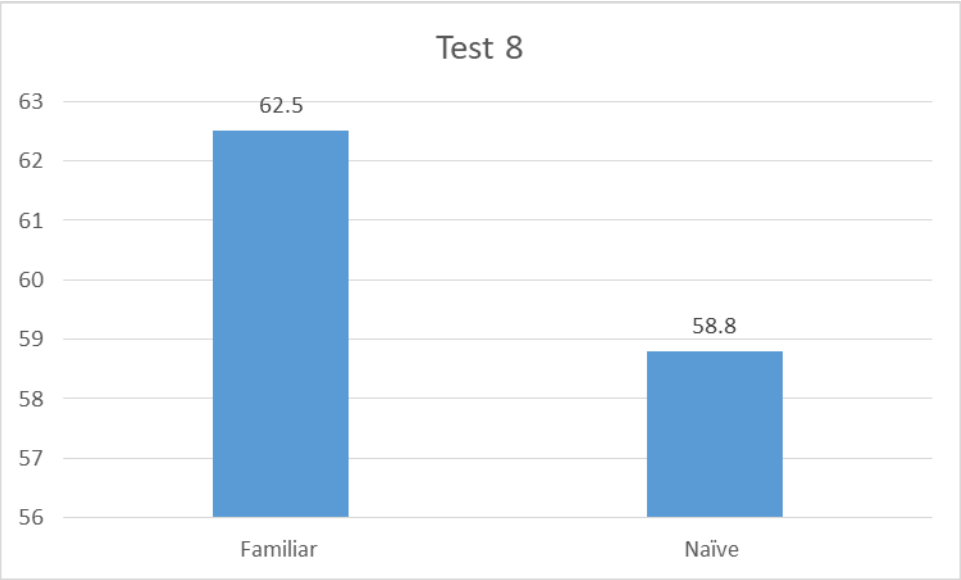
Test 8 Naïve and familiar results

For Test 8, results show a small positive advantage for familiar listeners (as above)

Test 8 Graph of naïve and familiar scores



Graph of naïve and familiar using percentages



Test 8 Listener scores for naïve and familiar listeners

Number	F/N	T8/8
1	F	7
2	N	4
3	N	7
4	F	8
5	N	7
6	F	7
7	N	5

8	N	7
9	N	6
10	N	3
11	N	4
12	F	6
13	F	4
14	N	7
15	N	7
16	F	5
17	N	5
18	N	5
19	F	8
20	F	7
21	N	5
22	F	5
23	N	6
24	F	8
25	N	4
26	N	6
27	F	7
28	N	5
29	F	4
30	F	6
31	N	6

32	N	6
33	F	2
34	F	5
35	F	8
36	F	5
37	F	5
38	N	4
39	F	6
40	F	3

T Test results for Test 8 were p= 0463498

Test 8a

Rational for Test 8A

The second open test did not use specific context to guide listeners and SV responses could not be predicted. This test identified listener intelligibility for open utterances. In addition, 6 of the 7 participant responses were contiguous, providing data on listener ability to perceive meaning in continuous utterances.
The response set included 7 utterances from 1 – 5 words in length, totalling 21 words where contractions (3) were transcribed and counted as 2 words, whether transcribed in the contracted or extended form.
Thus Test 8a required transcription of 21 words by 40 listeners to total 840 words.

Responses were both separate (1) and contiguous (6). Test 8A with answers
Listen to the questions, then write down the answers you think you hear.

Have you ever recorded your voice before? Never

Can you ride a bike? Yes, everyday

Are you ok about recording, you seem a bit worried? I am nervous

How do you feel about going to college? I’m frightened

What did you want me to get, what sort of present were you thinking? Flowers for her birthday

How did you know the answer to that question?

I learnt that

Is your teacher coming to join us today? She can’t be here.

Results.

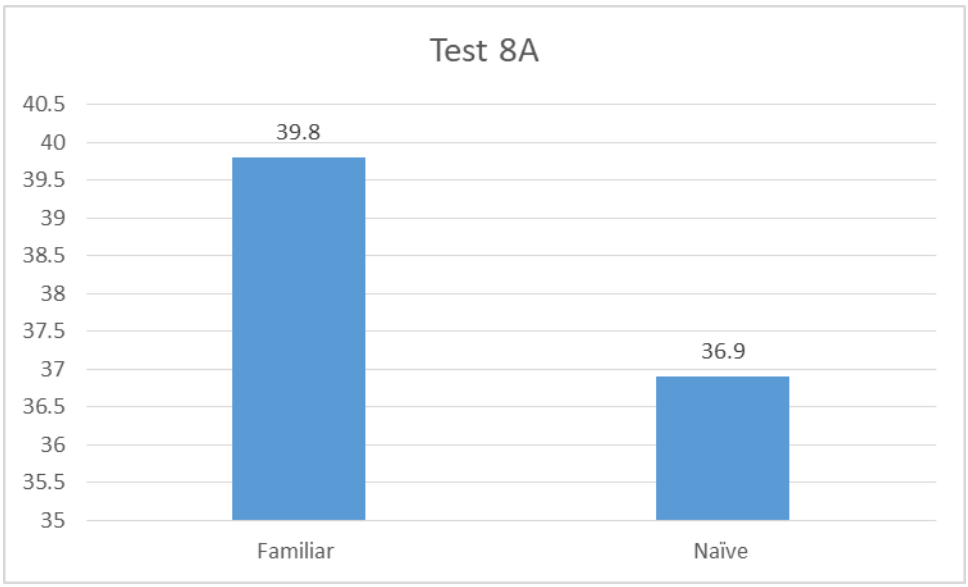
Following Test 8A, results were computed. The total number of words correctly identified provided the measure of percentage intelligibility for open sentences The table below details outcomes for each utterance and identifies the overall percentage intelligibility for all questions as 38.3%. This is significantly lower than the percentage intelligibility for the one word closed listener tests, suggested that open sentences were more challenging for listeners.

Test 8A results

Question 8A Correctly Scored			
Question	Word	Score	Percentage
a	never	36	90.0
b	yes everyday	42	52.5
c	I am nervous	56	46.7
d	I am frightened	47	39.2
e	flowers for her birthday	20	12.5
f	I learnt that	53	44.2
g	she can not be here	68	42.5
	Total	322	
	Max	840	38.3

Listener scores for Test 8A

Test Eight A Results				
Listener Number	Familiar Naïve	Correct Words	Out of	Percentage
1	Familiar	11	21	52
2	Naïve	10	21	48
3	Naïve	4	21	19
4	Familiar	13	21	62
5	Naïve	6	21	29
6	Familiar	6	21	29
7	Naïve	3	21	14
8	Naïve	11	21	52
9	Naïve	3	21	14
10	Naïve	8	21	38
11	Naïve	6	21	29
12	Familiar	9	21	43
13	Familiar	7	21	33
14	Naïve	10	21	48
15	Naïve	11	21	52
16	Familiar	10	21	48
17	Naïve	8	21	38
18	Naïve	7	21	33
19	Familiar	7	21	33
20	Familiar	7	21	33
21	Naïve	8	21	38
22	Familiar	4	21	19
23	Naïve	9	21	43
24	Familiar	7	21	33
25	Naïve	7	21	33
26	Naïve	9	21	43
27	Familiar	10	21	48
28	Naïve	7	21	33
29	Familiar	7	21	33
30	Familiar	7	21	33
31	Naïve	8	21	38
32	Naïve	9	21	43
33	Familiar	6	21	29
34	Familiar	12	21	57
35	Familiar	8	21	38
36	Familiar	12	21	57
37	Familiar	9	21	43
38	Naïve	11	21	52
39	Familiar	10	21	48
40	Familiar	5	21	24



Test 9

Test 9 required transcription of 48 words x 40 listeners to total 1920 SV words Test 9 comprised 20 questions. .Responses were both separate and contiguous . Five of the questions included contextual clues. Fifteen open responses include contiguous utterances of 2 – 4 words

Test 9 was conducted following an end of term break where staff changes frequently occur. Many of the original listeners for previous tests were no longer available, with inevitable changes in the listener set. The changes also altered the naïve familiar balance (27 naïve, 13 familiar) so that there was no longer an equal number of each. Effects of naïve and familiar listeners on intelligibility scores were therefore not computed for this test and comparison with earlier tests was not possible.

Test 9 with answers

When you go out on the mini bus, tell me the best place to go.

The Park

What colour is your jumper?

Purple

Did anything come in the post?

Letters

How’s your mum’s hand today?

It’s fine.

What do you like to do at school?

Swimming

Oooh a very dangerous animal, snap snap. What is it?

Crocodile

Who do you talk to at home?

I talk to mum

When do you want to go swimming?

Right now

What d’you think of that?

That is nice.

Use your headphones, who can you hear?

That is me

Would you like to go to college, Day Centre, or special unit?

College, yes

The therapist isn’t here yet.

She’s forgotten

Who are you talking to at home?

To Dad

Did I hear you properly? Am I correct?

You are right

So what did you think about the new room?

Little bit different

Do you like hearing your voice?

I love my voice

What do you think of the new headphones?

They are good

What's a good thing to do if people don't understand you?

Say it again

Tell me your favourite colour.

Red

See you again I hope Yes, thank you.

Results for Test 9

Overall percentage intelligibility for Test 9 was 47.2% for 40 listeners who correctly perceived 906 words out of 1920 target responses (as above) Marked variations between listeners were apparent, with the lowest score at 8 and the highest at 79. Due to the imbalance between naïve and familiar listeners, scores calculated for the effects of familiarity were for 13 familiar listeners, of which only 3 scored less than 50% while of 27 naïve listeners 21 achieved scores below 50% Familiar listeners had the advantage of increased exposure to SV utterances during all previous tests, while naïve listeners had no exposure to this form of phonation. Outcomes compared to the other tests may have been negatively impacted but further research, using equal listener sets are needed to investigate more fully.

T Test results for Test 9 Naïve and Familiar were p =69098E-05

Listener scores for Test 9

Test 9 Results				
Listener Number	Familiar Naïve	Correct Words	Out of	Percentage
1	F	33	48	69
2	F	23	48	48
3	F	38	48	79
4	N	27	48	56
5	F	19	48	40
6	N	24	48	50
x7	N	23	48	48
8	N	11	48	23
9	N	26	48	54
10	N	24	48	50
11	N	23	48	48
12	F	33	48	69
13	F	31	48	65
14	N	14	48	29
15	N	13	48	27

16	N	22	48	46
17	F	32	48	67
18	N	23	48	48
19	N	9	48	19
20	N	18	48	38
21	N	19	48	40
22	F	33	48	69
23	N	21	48	44
24	F	25	48	52
25	N	19	48	40
26	N	12	48	25
27	N	18	48	38
28	F	30	48	63
29	N	11	48	23
30	N	30	48	63
31	N	22	48	46
32	N	34	48	71
33	F	23	48	48
34	N	22	48	46
35	N	22	48	46
36	N	19	48	40
37	F	28	48	58
38	N	22	48	46
39	N	4	48	8

40	F	26	48	54
		906	1920	47.2

Range

The range for all listener scores was as follows:

Highest: 83 words correctly perceived Lowest: 51 words correctly perceived The resultant range is 32.
The percentage range is:

Highest percentage intelligibility: 69.7% Lowest percentage intelligibility: 42.9% The resultant range is : 26.8%.
The modal score across all tests is 65 (scored by 4 listeners

Comprehensibility

Data gathered from the intelligibility tests was examined for reference to comprehensibility.

Rational for examining comprehensibility.

Comprehensibility in Open Sentence Tests

The literature review identified the significance of comprehensibility compared to intelligibility in speech. Hustard (2011) proposes that a more complete description of the information bearing capacity of dysarthric speech may be provided by listener comprehension in conjunction with intelligibility measures. This was not relevant to the closed tests, or to Test 8 with 6 one word responses and only 1 two word response. However, in Test 8A and Test 9, responses included contiguous utterances where key words conveyed the intended ‘message’ of the utterance, and minor words were not significant for the message. In measuring intelligibility scores in these tests, it became apparent that, in some cases, minor words were perceived and the important key words were not. Although minor words then contributed positively to intelligibility scores, the intended message was absent.

Measuring comprehensibility

Comprehensibility measured the extent to which listeners correctly identified the words that conveyed the ‘message’ by the participant. The researcher identified the, meaningful words required by the listener to comprehend the message contained in the complete sample. These were designated Key Words, while words that were not required for comprehension were designated Minor Words. Thus, for Test 8 A, question ‘What sort of present did you want me to get, what were you thinking?’ the participant responds,
‘Flowers for her birthday,’

Of the four words uttered, only ‘Flowers, birthday,’ are required to make clear the communicative intent of the participant. Consequently, the words essentially required

to transmit the intended message could be identified. Correct identification of these words by listeners could be measured and compared to percentage intelligibility for all words. As with intelligibility, identified words in the samples facilitating comprehension scored 1 point.

The procedure to designate words as key words or minor words and measure results was carried out as follows:
Words were designated as key words (K) or minor words (M) and the outcomes described.
Correct response

QUESTION 1 Have you ever recorded your voice before? Never

Question 1 is a one key word response, achieving 90% percentage intelligibility and comprehensibility.

QUESTION 2 Can you ride a bike? Yes K) everyday.M)

All listeners transcribed the word ‘Yes,’ achieving a high score (50%) for comprehension and intelligibility . The second word in the phrase (everyday) however is perceived by only 2 listeners for comprehension at 2.5 (rounded up to 3%) but, as this is a minor, less significant word, the score for comprehensibility remains high.

QUESTION 3 Are you OK about recording? You seem a bit worried I am M)

nervous K)

The minor words “I am” scored highly (61%) as shown in the graph and table above, but the key word for comprehension is ‘nervous,’ and achieves a low score (18%). The ‘message’ for this sentence is lost to most listeners. The difference between the two scores is 43%. However, minor words ‘I am’ is intelligible to 61% of listeners, achieving a high score for intelligibility.

QUESTION 4 How do you feel about going to college? I am M)

frightened

K)

Question 4 reflects the same issues observed in Question 3. The minor words ‘I am’ are intelligible to 55% of listeners, but the key word for comprehensibility is ‘Frightened’ and only 8% of listeners transcribed it correctly. The difference between the two scores is 47%. The essential element of the message is lost.
Interestingly, 6 listeners transcribed the adjective ‘frightened’ as ‘afraid’ – with the same meaning as frightened and therefore comprehending the intended message. If this is added to the score for comprehension, it equals 22.5%

QUESTION 5 What did you want me to get? What sort of present were you thinking?

Flowers K) for her M) birthday K)

Although there is not a high score for this question. Question 5 reverses the trend of the previous two sentences. – the message “FLOWERS BIRTHDAY” is comprehended by 21% of listeners, while the minor words ‘For her’ scores only 4%. The difference between the scores is 17%. The minor words ‘for her’ lie between the two key words Flowers and Birthday, perhaps acting as a distractor from the minor words, as listener perception focuses on the bi-syllabic key words.

QUESTION 6 How did you know the answer to that question? I M) learnt K)

that M)

44% of listeners perceived the minor words ‘I’ and ‘that’ while only 20% of listeners perceived the key word ‘learnt’ to comprehend the message. The difference between the score is 36% As with the other open sentences, intelligibility scores higher due to perception of the minor words, but the essential key word ‘learnt,’ is not perceived in high numbers.

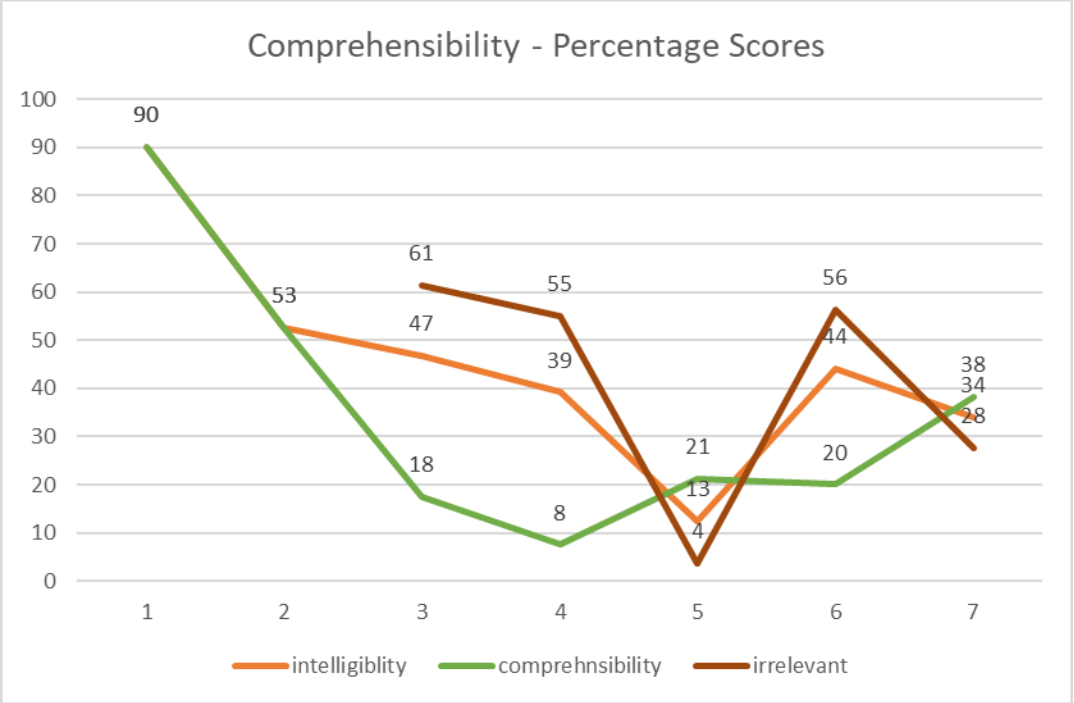
QUESTION 7 Is your teacher coming to join us today? She K) can M)

not K) be M) here K)

As seen on the graph, this phrase scores well for all words, achieving 34% for comprehension of key words, 28% for the minor words, with only 10% difference in the scores.
Outcomes for intelligibility and comprehensibility for 8A

The table and graph show where the message is lost if comprehensibility for key words is low and high for minor words. The intelligibility score benefits from the understanding of minor words, attributing scores for all words correctly transcribed, but examination of comprehensibility makes apparent the failure of listeners to perceive the intended message. The descriptive account of responses to the open sentences makes clear the discrepancies.

Subsequent to Test 8A, the graph below displays intelligibility versus comprehensibility for Test 8A
Intelligibility versus comprehensibility in Test 8A



Questions are on the horizontal axis, and percentage scored on the vertical axis.

The table below displays the percentage intelligibility and comprehensibility and the difference between scores

Question	1	2	3	4	5	6	7	Mean of percentages
Percentage intelligibility	90	53	47	39	13	44	34	46
Percentage comprehensibility	90	53	18	8	21	20	38	35
Minor words			61	55	4	56	28	41
Difference			43	47	17	36	10	

The point that Hustard (2011) makes, that comprehensibility provides a more complete description of the information bearing capacity of the utterance is an important one. For participants, due to the limitations of the exchange with the listener, the need to ensure that the intended message is communicated is paramount. Opportunities to repeat or correct the utterances are limited. Although it is positive that minor words were perceived as intelligible, as a means of communication, listener comprehension key words is significant.

Comprehensibility for Test 9

As with Test 8A, Test 9 was checked for comprehensibility, using the same procedure.

The table shows an example of the breakdown of key and minor words.

Where questions required a one word response, cells in the table below remain blank

e.g Question 2 where the response is ‘Purple’ so this is equally intelligible and comprehensible is correctly transcribed. As can be seen in the table below, minor words could score more than key words, again raising issues about the importance of comprehension compared to intelligibility Although the relevance of comprehension varied with the content, being less or more significant in different utterances, the use of both measures was more informative than intelligibility alone. Due to the novelty of the new phenomenon of SV utterances, regard for both measures needed consideration, as in the sample below:

Q1 – Response: The park

Intelligibility is a maximum of 80 points if 40 listeners transcribe “the” and “park” with one point for each word
The Key word is ‘park’ with a maximum of 40 points if correctly transcribed by 40 listeners.
The minor word ‘the’ also has a maximum of 40 points if correctly transcribed by 40 listeners.
listeners transcribed the key word ‘park.’

listeners transcribed the minor word “the”

The Intelligibility accrues points from both words, but it is the key word ‘Park’ that is the most significant and carries the ‘message’ of the participant’s response.
The tables below shows listener scores for intelligibility and comprehensibility for 20 questions on Test 9
Where the cells are blank, the response is a one word answer, equally comprehensible and intelligible if correct and therefore with no percentage difference between either category.

Question	Key Words	Max	Minor Words	Max	Intelligibility	Max
1	20	40	21	40	41	80
2	39	40			39	40
3	18	40			18	40
4	11	40	39	80	50	120
5	18	40			18	40
6	20	40			20	40
7	17	40	41	120	58	160
8	32	40	22	40	54	80
9	24	40	41	80	65	120
10	19	40	29	80	48	120
11	30	40	12	40	42	80

12	24	40	48	80	72	120
13	23	40	7	40	30	80
14	14	40	34	80	48	120
15	1	40	35	80	36	120
16	10	80	34	80	44	160
17	12	40	37	80	49	120
18	33	80	12	40	45	120
19	23	40			23	40
20	38	40	68	80	106	120
	426	880	480	1040	906	1920

Table 2 showing results of key and minor words

	Key	Minor	Intelligibility
Word Scored	426	480	906
Total Words	880	1040	1920
Percentage	48.4	46.2	47.2

Comparison of intelligibility between closed and open tests

Closed tests, using one word responses, achieved higher scores and percentage intelligibility than did open tests.
Comparison between both closed and open tests identified that single words were most intelligible to listeners.
Open tests 8, 8a and 9 achieved lesser scores, with percentage intelligibility reducing as contiguous sentences became more complex and (possibly) less predictable.
Comparison between intelligibility and comprehensibility indicated the importance of both measures, particularly if utterances were to be used communicatively.
High scores were consistently evident for particular utterances in both the open tests and closed tests (irrespective of context or other cues) and further investigation is required to determine the attributes in the SV utterances or the listeners that contributed to these scores, in comparison to other responses.
The outcomes of the listener tests of intelligibility potentially offer insight into a listener profile best suited to transcription/interpretation of SV utterances. Examination of the relationship within and between listeners in transcribing utterances need further investigation in order to identify the features most

Final intelligibility scores overall

	Scored	Max Score	Percentage
Test 1	122	200	61
Test 2	183	200	91.5
Test 3	361	400	90.25

Test 4	160	240	66.7
Test 5	179	200	89.5
Test 6	161	200	80.5
Test 7	204	240	85
Test 8	219	320	68.4
Test 8A	322	840	38.3
Test 9*	906	1920	47.2
Mean			71.80%
Total	2817	4760	59.20%

*Test 9 contains 23 different listeners to tests 1-8A.

Results for the open tests scored for words correct, quantified as percentage intelligibility
Test 8 required transcription of 8 words by 40 listeners to total 320 words Test 8 set target words in context.

Results for Test 8

Question 8 Correctly Scored			
Question	Word	Score	Percentage
a	England	35	87.5
b	David Cameron	42	52.5

c	Elizabeth	36	90
d	Paris	34	85
e	Washington	16	40
f	hundred	28	70
g	Thursday	34	85
	Total	225	
	Max	320	70.3

T Test results for Test 8 were p= 0463498

Test 8A

Question 8A Correctly Scored			
Question	Word	Score	Percentage
a	never	36	90.0
b	yes everyday	42	52.5
c	I am nervous	56	46.7
d	I am frightened	47	39.2
e	flowers for her birthday	20	12.5
f	I learnt that	53	44.2
g	she can not be here	68	42.5
	Total	322	

Max	840	38.3

Test 9

Test 9 required transcription of 48 words x 40 listeners to total 1920 SV words Test 9 comprised 20 questions. .Responses were both separate and contiguous . Five of the questions included contextual clues. Fifteen open responses include contiguous utterances of 2 – 4 words

Test 9

Question 9 Correctly Scored			
Question	Utterance	Score	Percentage
1	the park	41	51.3
2	purple	39	97.5
3	letters	18	45.0
4	it is fine	50	41.7
5	swimming	18	45.0
6	crocodile	20	50.0
7	I talk to mum	58	48.3
8	right now	54	67.5
9	that is nice	65	54.2

10	that is me	48	40.0
11	college yes	42	52.5
12	she has forgotten	72	60.0
13	to dad	30	37.5
14	you are right	48	60.0
15	little bit different	36	30.0
16	I love my voice	44	27.5
17	they are good	49	40.8
18	say it again	45	37.5
19	red	23	57.5
20	yes thank you	106	88.3
	Total	906	
	Max	1840	49.2

Table ….shows the ranked order of tests

Ranked order of tests

Test	Score
Test 2	91.5
Test 3	90.3
Test 5	89.5
Test 7	85.0

Tests 6	80.5
Test 4	66.7
Test 1	61.0

CVC words and scores

Test 1	Dad	60%
Test 2	Yes	100%
Bus	95%	
Dad	87%	
Mum	90%	
Sit	85%	
Test 3	Yes	100%
Test 5	Red	97.5%
Test 6	Fox	87.5%
Pig	62.5%	
Rat	75%	

Test scores overall

Question	1a	1b	1c	1d	1e
Score	35	24	34	15	14
Percentage	87.5	60	85	37.5	35

Question	2a	2b	2c	2d	2e

Score	40	38	35	36	34
Percentage	100	95	87.5	90	85

Question	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j
Score	37	39	40	40	40	33	32	25	38	37
Percentage	92.5	97.5	100	100	100	82.5	80	62.5	95	92.5

Question	4a	4b	4c	4d	4e	4f
Score	24	17	40	27	31	21
Percentage	60	42.5	100	67.5	77.5	52.5

Question	5a	5b	5c	5d	5e
Score	39	38	39	28	35
Percentage	97.5	95	97.5	70	87.5

Question	6a	6b	6c	6d	6e
Score	35	35	25	30	36
Percentage	87.5	87.5	62.5	75	90

Question	7a	7b	7c	7d	7e	7f
Score	40	40	40	32	31	21
Percentage	100	100	100	80	77.5	52.5

Question	8a	8b	8c	8d	8e	8f	8g

Score	35	42	35	34	15	24	34
Percentage	87.5	52.5	87.5	85	37.5	60	85

Question	8Aa	8Ab	8Ac	8Ad	8Ae	8Af	8Ag
Score	36	42	56	47	20	53	68
Percentage	90.0	52.5	46.7	39.2	12.5	44.2	42.5

Results for Test 1

Test 1 - Correctly Scored from 40			
	Word	Score	Percentage
Test 1a	Speak	35	87.5
Test 1b	Dad	24	60
Test 1c	Something	34	85
Test 1d	Perfect	15	37.5
Test 1e	Lucky	14	35
	Total	122	
	Max	200	61%

T Test results for familiar and naïve for Test 1 were p = 0.233413

Test 2

Test 2 assessed the influence of CVC words on listener intelligibility for 5 target words Results for Test 2

Test 2 Correctly Scored			
Question	Word	Score	Percentage
a	Yes	40	100
b	Bus	38	95
c	Dad	35	87.5
d	Mum	36	90
e	sit	34	85
	Total	183	
	Max	200	91.5%

T Test results for familiar and naïve for Test 2 were p= 0.081037

Test 3

Test 3 assessed the influence of the number of syllables and word length on listener intelligibility for 10 target words Results for Test 3

	Target word	Score out of 40	Percentage
intelligibility			

Question 3 Correctly Scored			
Question	Word	Score	Percentage
a	Budgie	37	92.5
b	Medicine	39	97.5
c	Purple	40	100
d	Yes	40	100
e	Better	40	100
f	Said	33	82.5
g	Fabulous	32	80
h	Right	25	62.5
i	Summer	38	95
j	Brilliant	37	92.5
	Total	361	
	Max	400	90.25%

T Test Results for Familiar and Naïve for Test 3 were p= 0.0875 Test 4
Test 4 assessed the influence of distinct phonetic differences on listener intelligibility for 6 target words
Results for Test 4

Question 4 Correctly Scored

Question	Word	Score	Percentage
a	Home	24	60
b	Father	17	42.5
c	Christmas	40	100
d	Super	27	67.5
e	Care	31	77.5
f	Private	21	52.5
	Total	160	
	Max	240	66.7

T Test Results for Familiar and Naïve for Test 4 were p= 0191505 Test 5
Test 5 assessed the influence of semantic context (colour) on listener intelligibility for 5 target words
Results for Test 5

Question 5 Correctly Scored			
Question	Word	Score	Percentage
a	Blue	39	97.5
b	Yellow	38	95
c	Red	39	97.5
d	Orange	28	70
e	Purple	35	87.5
	Total	179	

Max	200	89.5

T Test Results for Familiar and Naïve for Test 5 were p= 585165 Test 6
Test 6 assessed the influence of semantic context (animals) on listener intelligibility for 5 target words
Results for Test 6

Question 6 Correctly Scored			
Question	Word	Score	Percentage
a	Fox	35	87.5
b	Sheep	35	87.5
c	Pig	25	62.5
d	Rat	30	75
e	Turkey	36	90
	Total	161	
	Max	200	80.5

T Test Results for Familiar and Naïve for Test 6 were p= 585165 Test 7
Test 7 assessed the influence of perceptual experience (all 6 words by the same speaker) on listener intelligibility for 6 target words

Results for Test 7

Question 7 Correctly Scored			
Question	Word	Score	Percentage
a	Stop	40	100
b	Happy	40	100
c	Myself	40	100
d	Sorry	32	80
e	Dream	31	77.5
f	Listen	21	52.5
	Total	204	
	Max	240	85

Test results for Test 7 Familiar and Naïve were p= 1

The tables below identifies the intelligibility results for open tests Test 8, Test 8A and Test 9
Table … shows the results for all questions in open Test 8

Question 8 Correctly Scored			
Question	Word	Score	Percentage
a	England	35	87.5
b	David Cameron	42	52.5
c	Elizabeth	35	87.5
d	Paris	34	85
e	Washington	15	37.5

f	hundred	24	60
g	Thursday	34	85
	Total	219	
	Max	320	68.4

Table shows the results for all questions in open Test 8A

Question 8A Correctly Scored			
Question	Word	Score	Percentage
a	never	36	90.0
b	yes everyday	42	52.5
c	I am nervous	56	46.7
d	I am frightened	47	39.2
e	flowers for her birthday	20	12.5
f	I learnt that	53	44.2
g	she can not be here	68	42.5
	Total	322	
	Max	840	38.3

Table shows the results for all questions in open Test 9

Question 9 Correctly Scored			
Question	Utterance	Score	Percentage

1	the park	41	51.3
2	purple	39	97.5
3	letters	18	45.0
4	it is fine	50	41.7
5	swimming	18	45.0
6	crocodile	20	50.0
7	I talk to mum	58	48.3
8	right now	54	67.5
9	that is nice	65	54.2
10	that is me	48	40.0
11	college yes	42	52.5
12	she has forgotten	72	60.0
13	to dad	30	37.5
14	you are right	48	60.0
15	little bit different	36	30.0
16	I love my voice	44	27.5
17	they are good	49	40.8
18	say it again	45	37.5
19	red	23	57.5
20	yes thank you	106	88.3
	Total	906	
	Max	1840	49.2

Appendix XIX: Performance Scales

Performance - P Scale - attainment targets for pupils with special educational needs

June 2017 Contents

Introduction

This document specifies performance attainment targets (P scales) and performance descriptors for pupils aged 5-16 with special educational needs (SEN) who are working below the standard of the national curriculum tests and assessments1. These apply to key stages 1, 2 and 32.

1 National curriculum (NC) tests and assessments consist of statutory NC tests and teacher assess- ment frameworks at the end of key stage 1 and key stage 2. Those working below the standard of these assessments are assessed using either the pre-key stage standards or P scales.
2 Key stages are defined in Section 82 of the Education Act 2002.

In key stage 4, the P scales and performance descriptors can be used as non- statutory guidelines describing some of the types and range of performance that pupils with SEN who cannot access the national curriculum might characteristically demonstrate.

The use of P scales is statutory for reporting teacher assessment in English, mathematics and science to the Department for Education at the end of key stages 1 and 2. P scales can also be used for reporting teacher assessment to parents in other national curriculum subjects and at other times.

Additionally, the annex to this document contains attainment targets and performance descriptors for religious education (RE). This is not statutory, and should be read as guidelines describing the types and range of performance that pupils with SEN who are working below the standard of the national curriculum might characteristically demonstrate.

Performance descriptors

The performance descriptors for P1-P3 are the same across English, mathematics and science. The descriptions show the range of overall performance that pupils might demonstrate. Subject-focused examples are included to illustrate some of the ways in which attainment might be identified in different subject contexts.

If a pupil is working at P1i-P3ii in English, then using reading, writing, speaking or listening performance descriptors would not normally be appropriate. If a pupil is working above P3ii in English, then separate performance descriptors (P4-P8) can

be given in reading, writing, speaking or listening and an overall English performance descriptor is not expected.

This also applies to mathematics, number, using and applying mathematics, and shape, space and measures. For science, a single descriptor from P1-P8 should be given. There may be exceptional circumstances where a pupil is judged to be at P1i-P3ii in English and / or mathematics but at P4-P8 in a particular element of the subject. The table on page 4 demonstrates this. The school management information system should allow these different scales to be recorded and will transfer all scales entered for each pupil.

P scale descriptors P4 to P8 describe pupils' performance in a way that indicates the emergence of skills, knowledge and understanding in each subject. The descriptors are characteristic of the types of attainment that the learners are likely to demonstrate.

Subject	Reportable score
English	P1i, P1ii, P2i, P2ii, P3i, P3ii
reading writing speaking listening	P4, P5, P6, P7, P8
Mathematics	P1i, P1ii, P2i, P2ii, P3i, P3ii

number using and applying mathematics shape, space and measures	P4, P5, P6, P7, P8
Science	P1i, P1ii, P2i, P2ii, P3i, P3ii, P4, P5, P6, P7, P8

Early Years Foundation Stage (EYFS)

If a pupil has special educational needs and their EYFS attainment against the EYFS profile has not been demonstrated at the end of this stage, the school may wish to continue with an early years curriculum to support the pupil's learning and development. In this case, the EYFS profile, rather than P scales, should be used for assessment, as it may be suitable in year 1 for a small number of pupils.

If schools choose to assess pupils using P scales towards the end of year 1, teachers should base such judgements on a review of evidence gathered from everyday teaching and learning. Professional judgment should be used to decide which P scale descriptor best fits a pupil's performance.

Further guidance

Arrangements for statutory assessment at the end of each key stage are set out in detail in the Standards and Testing Agency's annual booklets 'Assessment and Reporting Arrangements', available via www.GOV.UK.

Schools are not required by law to assess the content printed inside square brackets in this document; this is included for guidance only.

English

Performance descriptors across subjects:

P1 (i) Pupils encounter activities and experiences

They may be passive or resistant
They may show simple reflex responses, [for example, startling at sudden noises or movements]
Any participation is fully prompted.

P1 (ii) Pupils show emerging awareness of activities and experiences

They may have periods when they appear alert and ready to focus their at- tention on certain people, events, objects or parts of objects [for example, attending briefly to interactions with a familiar person]
They may give intermittent reactions [for example, sometimes becoming ex- cited in the midst of social activity].

P2 (i) Pupils begin to respond consistently to familiar people, events and objects

They react to new activities and experiences [for example, withholding their attention]
They begin to show interest in people, events and objects [for example, smil- ing at familiar people]
They accept and engage in coactive exploration [for example, focusing their attention on sensory aspects of stories or rhymes when prompted].

P2 (ii) Pupils begin to be proactive in their interactions

They communicate consistent preferences and affective responses [for ex- ample, reaching out to a favourite person]
They recognise familiar people, events and objects [for example, vocalising or gesturing in a particular way in response to a favourite visitor]
They perform actions, often by trial and improvement, and they remember learned responses over short periods of time [for example, showing pleasure

each time a particular puppet character appears in a poem dramatised with sensory cues]
They cooperate with shared exploration and supported participation [for ex- ample, taking turns in interactions with a familiar person, imitating actions and facial expressions].

P3 (i) Pupils begin to communicate intentionally

They seek attention through eye contact, gesture or action
They request events or activities [for example, pointing to key objects or peo- ple]
They participate in shared activities with less support. They sustain concen- tration for short periods.
They explore materials in increasingly complex ways [for example, reaching out and feeling for objects as tactile cues to events]
They observe the results of their own actions with interest [for example, lis- tening to their own vocalisations]
They remember learned responses over more extended periods [for exam- ple, following the sequence of a familiar daily routine and responding appro- priately].

P3 (ii) Pupils use emerging conventional communication

They greet known people and may initiate interactions and activities [for example, prompting another person to join in with an interactive sequence].
They can remember learned responses over increasing periods of time and may anticipate known events [for example, pre-empting sounds or actions in familiar poems]
They may respond to options and choices with actions or gestures [for ex- ample, by nodding or shaking their heads]
They actively explore objects and events for more extended periods [for ex- ample, turning the pages in a book shared with another person]
They apply potential solutions systematically to problems [for example, bring- ing an object to an adult in order to request a new activity].

Speaking

P4 Pupils repeat, copy and imitate between 10 and 50 single words, signs or phrases or use a repertoire of objects of reference or symbols
They use single words, signs and symbols for familiar objects [for example, cup, biscuit], and to communicate about events and feelings [for example, likes and dislikes].

P5 Pupils combine two key ideas or concepts

They combine single words, signs or symbols to communicate meaning to a range of listeners [for example, ‘Mummy gone’ or ‘more drink’]
They make attempts to repair misunderstandings without changing the words used
[for example, by repeating a word with a different intonation or facial expression]
Pupils use a vocabulary of over 50 words.
P6 Pupils initiate and maintain short conversations using their preferred medium of communication
They ask simple questions to obtain information [for example, ‘Where’s the cat?’]
They can use prepositions, such as ‘in’ or ‘on’, and pronouns, such as ‘my’ or ‘it’, correctly.

P7 Pupils use phrases with up to three key words, signs or symbols to communicate simple ideas, events or stories to others [for example, ‘I want big chocolate muffin’]
They use regular plurals correctly
They communicate ideas about present, past and future events and experi- ences, using simple phrases and statements [for example, ‘We going cinema on Friday’]
They contribute appropriately one-to-one and in small group discussions and role play
They use the conjunction and to link ideas or add new information beyond what is asked.

P8 They link up to four key words, signs or symbols in communicating about their own experiences or in telling familiar stories, both in groups and one-to- one [for example, ‘The hairy giant shouted at Finn’]
They use an extensive vocabulary to convey meaning to the listener
They can use possessives [for example, 'Johnny’s coat']
They take part in role play with confidence
They use conjunctions that suggest cause [for example, ‘cos,’ to link ideas].

Listening

P4 Pupils demonstrate an understanding of at least 50 words, including the names of familiar objects
Pupils respond appropriately to simple requests which contain one key word, sign or symbol in familiar situations [for example, ’Get your coat’, ‘Stand up’ or ‘ Clap your hands’].

P5 Pupils respond appropriately to questions about familiar or immediate events or experiences [for example, ‘Where is the ball?’, ‘What are you doing?’, ‘Is it yellow?']
They follow requests and instructions containing at least two key words, signs or symbols [for example, ‘Put the spoon in the dish’, ‘Give the book to Johnny’].

P6 Pupils respond to others in group situations [for example, taking turns appropriately in a game such as ‘Pass the parcel’]
They follow requests and instructions with three key words, signs or symbols [for example, ‘Give me the little red book’].

P7 Pupils listen, attend to and follow stories for short stretches of time

They follow requests and instructions with four key words, signs or symbols [for example, ‘Get the big book about dinosaurs from the library’]
They attend to, and respond to, questions from adults and their peers about experiences, events and stories [for example, ‘Where has the boy gone?'].

P8 Pupils take part in role play with confidence

Pupils listen attentively. They respond appropriately to questions about why or how [for example ‘Why does a bird make a nest?’, ‘How do we copy this picture?’].

Appendix XX Early years foundations stages

EARLY YEARS FOUNDATION STAGES
Communication and language
Listening and attention: children listen attentively in a range of situations. They listen to stories, accurately anticipating key events and respond to what they hear with relevant comments, questions or actions. They give their attention to what others say and respond appropriately, while engaged in another activity.

Understanding: children follow instructions involving several ideas or actions. They answer ‘how’ and ‘why’ questions about their experiences and in response to stories or events.

Speaking: children express themselves effectively, showing awareness of listeners’ needs. They use past, present and future forms accurately when talking about events that have happened or are to happen in the future. They develop their own narratives and explanations by connecting ideas or events

Standards & Testing Agency

Early Communication and Language

Stage	Listening and Attention	Understanding (Receptive Language)	Talking (Expressive Language)
0-11 months	Turns toward a familiar sound then locates range of sounds with accuracy. Listens to, distinguishes and responds to intonations and sounds of voices.	Stops and looks when hears own name. (by 12 months □)	Gradually develops speech (babbling) to communica adults; says sounds like nono, gogo'. (by 11 months

	Quietens or alerts to the sound of speech. Fleeting Attention – not under child's control, new stimuli takes whole attention.		
8-20 months	Concentrates intently on an object or activity of own choosing for short periods. Pays attention to dominant stimulus – easily distracted by noises or other people talking. Moves whole bodies to sounds they enjoy, such as music or a regular beat. Has a strong exploratory impulse.	Responds to the different things said when in a familiar context with a special person (e.g. 'Where's Mummy?', 'Where's your nose?'). Understanding of single words in context is developing, e.g. 'cup', 'milk', 'daddy'	Uses single words. (by 16 □) Frequently imitates wor sounds. Enjoys babbling increasingly experiments using sounds and wor communicate for a ran purposes (e.g. teddy, mor byebye)
16-26 months	Listens to and enjoys rhythmic patterns in rhymes and stories. Enjoys rhymes and demonstrates listening by trying to join in with actions or vocalisations. Rigid attention – may appear not to hear.	Selects familiar objects by name and will go and find objects when asked, or identify objects from a group.	Beginning to put two words (e.g. 'want ball', 'more juice' months □) Uses different types of e words (nouns, verbs and ad e.g. banana, go, slee Beginning to ask simple que
22-36 months	Single channelled attention. Can shift to a different task if attention fully obtained – using child's name helps focus. (by 36 months □)	Identifies action words by pointing to the right picture, e.g., "Who's	Learns new words very rap is able to use th communicating.

	Listens with interest to the noises adults make when they read stories. Recognises and responds to many familiar sounds e.g. turning to a knock on the door, looking at or going to the door.	*jumping?" (by 30 months □)* Understands 'who', 'what', 'where' in simple questions (e.g. *Who's that/can? What's that? Where is.?)*. Developing understanding of simple concepts (e.g. *big/little*)	Uses action, sometimes wit talk, that is largely concer the 'here and now' (e.g. toward toy, saying *'I have it)* Uses a variety of questio *what, where, who)*. Uses simple sentences *Mummy gonna work*.') Beginning to use word endi *going, cats)*
30-50 months	Listens to others in one to one or small groups, when conversation interests them. Listens to stories with increasing attention and recall. Joins in with repeated refrains and anticipates key events and phrases in rhymes and stories. Focusing attention – still listen or do, but can shift own attention. Is able to follow directions (if not intently focused on own choice of activity).	Understands use of objects (e.g. *"What do we use to cut things?'*) Shows understanding of prepositions such as 'under', 'on top', 'behind' by carrying out an action or selecting correct picture. Beginning to understand 'why' and 'how' questions.	Beginning to use more sentences to link though using *and, because*). Can retell a simple past correct order (e.g. *went do hurt finger*). Uses talk to connect ideas what is happening and a what might happen next, re relive past experiences. Q why things happen and explanations. Asks e.g. *wh when, how.* Uses a range o (e.g. *play, playing, will play,*

n	40-60+ months	Sustains attentive listening, responding to what they have heard with relevant comments, questions or actions. Maintains attention, concentrates and sits quietly when appropriate. Two-channelled attention – can listen and do for short span. Integrated attention – can listen and do in range of situations with range of people; varies according to the demands of the task.	Understands humour, e.g. nonsense rhymes, jokes. Demonstrates understanding of "how?" and "why?" questions by giving explanations. Able to follow a story without pictures or props. Understands instructions containing sequencing words; first…after…last, and more abstract concepts – long, short, tall, hard soft, rough.	Extends vocabulary, espec grouping and naming, explo meaning and sounds of new Links statements and stic main theme or intention. Uses language to imag recreate roles and experie play situations. Uses talk to organise, seque clarify thinking, ideas, feel events. Introduces a storyline or into their play.

Notes on monitoring early communication and language

Observation and best-fit judgements

Judgements of a child's stage of development are made through a process of ongoing observational assessment. Observation involves noticing what children do and say in a range of contexts, and includes information from the family about what children do and say at home.

For children learning English as an additional language, it is important to find out from families about how children use language in their mother tongue and how they communicate at home.
The assessment is a ‘best fit’ match to a stage band. This involves considering what is known about the child, and matching it to the development described in the bands. This should be considered separately for each strand of communication and language.
Within each band, a judgement will be made in two levels ‘Emerging’ when a child shows some development at that level, or ‘Secure’ – either when most of the statements reflect the child’s current development.
Development of speech sounds need not be assessed specifically, but it is useful to be aware of typical development which is described in the table to the right. NB EYFS produce ‘Guidance on typical development of speech sounds.’ This section is not included here as part of this research study as participants do not produce verbal speech. Emphasis in this research is on language acquisition and use

•
Checkpoints

Alongside the ‘best fit’ judgement, certain ‘Checkpoint’ statements are included. Marked with a flag and a specific age, these are particular statements which should be noted.
Where a child has not reached a Checkpoint by the age indicated, this is not necessarily a sign of difficulty. The Checkpoint statements serve as an alert for close monitoring including discussion with the family, and perhaps further assessment or support.
Making good progress

The goal of monitoring children’s development is to plan and provide more accu- rate support for each child to make good progress.
How well a setting helps children to make good progress can be determined by analysing the proportion of children who are at risk of delay, as expected, or ahead of expectations in each strand of language and communication. If children are making accelerated progress, the proportion of children at risk of delay should decrease over time.

In considering whether a child is at risk of delay, as expected, or ahead in each strand of language and communication, it is necessary to consider the child's ac- tual age in months in relation to the overlapping age bands. If a child is within two months of the end of the age band and development is not yet within the band or is judged to be 'Emerging', then a judgement of 'risk of delay' would be appro- priate.

EYFS

Communication and language development

This involves giving children opportunities to speak and listen in a range of situations and to develop their confidence and skills in expressing themselves.
ELG 01 Listening and attention: children listen attentively in a range of situations. They listen to stories, accurately anticipating key events and respond to what they hear with relevant comments, questions or actions. They give their attention to what others say and respond appropriately, while engaged in another activity.
ELG 02 Understanding: children follow instructions involving several ideas or actions.

They answer 'how' and 'why' questions about their experiences and in response to stories or events.
ELG 03 Speaking: children express themselves effectively, showing awareness of listeners' needs. They use past, present and future forms accurately when talking about events that have happened or are to happen in the future. They develop their own narratives and explanations by connecting ideas or events.

Exemplification of expected descriptors

This document demonstrates national standards for one of the 17 early years foundation stage (EYFS) profile early learning goals (ELGs). It shows the level of learning and development expected at the end of the EYFS.
The collection of evidence in this document illustrates the ‘expected’ descriptor. No one piece of evidence meets the ELG as a standalone item; together they illustrate the pitch and breadth of a particular ‘expected’ level of learning and development.
This document illustrates how information can be gathered to support EYFS profile judgements using a variety of evidence and forms of presentation. However there is no prescribed method of gathering evidence, nor any expectation that it should be recorded as shown in this document. The exemplification is not intended to be an exhaustive list for schools to follow.
The examples in this collection include ‘one off’ observations, samples of children’s work, photographs and contributions from parents. Many methods of recording a child’s attainment are not included in this exemplification for practical reasons (for example video recordings). Practitioners will also build up a significant professional knowledge of each child which will not be recorded but which must be considered when EYFS profile judgements are made.
When completing an EYFS profile, practitioners should make a best-fit judgement for each ELG. Practitioners must consider the entirety of each ELG, taking an holistic view of the descriptor in order to create the most accurate picture of the child’s overall embedded learning. Sections of each descriptor must not been seen in isolation.
Exemplification material should always be viewed in the context of a specific aspect of learning in order to retain an accurate focus. However, practitioners should be aware

that a child’s learning and development are not compartmentalised. Focusing on one aspect of learning will shed light on several other related areas.

Appendix XXI Samples of morphemes

Morphemes	
Participant 15	
Is that me, everyone heard	5
Word/s..yes…	3
That's wonderful	3
My friend/s say nothing..I talk	7
Rosie, we'/re off	4
I think ..it'/s wonderful……I said it	8
It'/s plain that, mine'/s blue	7
True . I think we'/ll learn the date	8
I'/m special..	3
I'/d like that	4
52/10 = 5.2	

Participant 20			
This one'/s good, man came to mend it	9		
My parent/s ..They have heard	6		
I'/m talking in the house	6		
Right then, I was try/ing…….to whisper	8		
Please…. make…… my….. voice….. right	5		
We keep it…if they let me talk	8		
I want..this..I need help	6		
I ask/ed for a drink	6		
I'/m talk/ing..Great.... with this	7		
It'/s someone'/s birthday	5		
66/10			

Participant 18

I like feel/ing thing/s like this	8
Listen, I know it'/s true	6
I could have my bag on there	7
Could I learn to rely on that?	7
With the computer, I could try	6
I'/ve come here Rosie …to record	7
I'/ll hear about myself	5
You have help/ed me Rosie,my parent/s have met you	12
Wait, …we'/ll buy .. the whole thing	7
They are not here now	7

72/10

Participant 1	
It/s call/ed 'Luke' , it'/s a silly name	11
Beware the man, he speak/s	6
I'/ve found this gives me energy	7
London, where the submarine/s are built in America	9
Listen Rosemary, let'/s do it again, it/s hard	10
We go/ing to stay, with the parents	8
She can'/t be, giv/ing the lesson	8
The first thing I want you to see, how dear it was (whispers folder)	12
We can use it, without mum	6
We did/n't realise you would be leav/ing in a year	12

89/10

Participant 8	
Why don'/t you call and visit	7
I need to mention, my hand	6
You kept me say/ing this	6
3:49.443 It'/ll be the first question of every person	9
0:25.500 I'/m sure…work/ing …headphones	6
0:42.500 Rose, my parent/s ..keep speak/ing	7
I expect she'/s a teacher	6
0:27.087 My mother, she'/d relax and I'/m part of that	11
They have elected a madman called President Trump	8
Everybody's cheerful … mad on the bus	7
73/10	

Appendix XXII Step 3 Kallio (2016) – formulating the Semi Structured Interview Guide

I recorded your soft voice inside you. Can you tell me about using that voice	
What did you think about the sound of your voice	Views, opinions, idea
Can you tell me how you speak like that	Views, opinions, idea
Listen to the recording. What do you think you hear	Views, opinions, idea
Do you think I hear the same as you	Views, opinions, idea
Will other people hear you	Views, opinions, idea
Tell me about hearing you out loud.	Views, opinions, idea
What are you saying	Views, opinions, idea

What do you think about your voice	Views, opinions, idea
How do you feel about hearing your voice	Views, opinions, idea
What would you like me to do with the recording of your voice	Plans, future, preser
Should we tell other people about your speaking	Views, opinions, idea advocacy
What can we use your voice for	Plans, future, preser
Use your voice to tell me about yourself	Plans, future, preser
Tell about the things you like to do in school/college	Plans, future, preser
What do you think about school/college	Self advocacy, planc
Can you remember when you first started speaking	Past, views, opinions
Have you always been talking very softly	Views, opinions idea
Can you tell me how long you have been speaking for	Plans, future, preser
Is it difficult to speak out loud	Views, opinions, idea
Is it a struggle to use your voice	Views, opinions, idea
Tell me about learning to speak in your soft voice	Views, opinions, idea
Is it a struggle to use your voice?	Views, opinions, idea
Tell me about learning to speak in your soft voice	Views, opinions, idea

Appendix XXIII: Coding the data

Speaking	Meaning	Participant
Audible voice playback Introduct. First replay – listening for those little soft words inside' Talking, voice , hearing, heard, New experience.	Is it true? – dismissive Rubbish, can't Mouth does/ doesn't work I could always do it. What does it sound like? – is it 'normal?' – funny ? Opinions, views, ideas Equipment makes it work – headphones needed to talk Foreign language? I speak English	P.2, 3.12,20,8, 5,15 , 14, 16,
Emotions – past failures,	Very emotional, comparison of before and after. sad, desperate. Lonely, now happy, dream, always wanted What does it mean for me now? Love that sound – Wow! Family will be thrilled – tell parents – get mum/dad	P.17,8,1,11, 20,2,13,3,14,12
Plans	Get help – learn with Rosie/teacher – plan, dream. Think it can be taught! Talk with dad/mum/friends/in class Learn to talk Communicate – tell others Get equipment - computer Prove I'm clever Keeping doing it – we've won, we	P14,13,5,10,1,18,13,8,11,15

	have done it	
About me	Am I clever Worries about health, bereavement Future- fears about leaving Things I like – swimming, schools, shops, talking. Not stupid, clever, brilliant My friends say nothing – I'm better?	P.15, 3,8,1,14,13,3,9,7, 11, 1
Learned to speak SV – real language	Audible unknown Unexpected Not aloud Never heard by me or others- didn't know – 'soft' sound Always there in my head – started long ago Aloud not possible, very difficult – hard for others to understand (dysarthric) Nervous to try – discouraged others – stopped us Different language	P.16, 18, 9,1,12,5,7, 15,2,11,14,7,9,20,13,3,6,8,4

Appendix XXIV

Sub theme		
Sub theme Voice	Meaning	Participant
Ownership – I have it Presenting voice Voice with sound Audible – others know Credible/ legitimate/believe	Never heard	Participant 6
	This is mine	Participant 1
	Showing to others	Participant 8
	Knew it existed unheard	Participant 2
	I can hear it	Participant 2
Quality		
Voice description	Concern – expectations	Participant 3
Presenting voice	Normal??	Participant 12
Audible, with sound	Good, looking good	Participant 14
	Tell researcher	Participant 1
	Others Listen	

	Others Hear/heard	
Quality		
Voice description	Concern – expectations	Participant 3
Presenting voice	Normal??	Participant 12
Audible, with sound	Good, looking good	Participant 14
	Tell researcher	Participant 1
	Others Listen	
	Others Hear/heard	

Appendix XXV: Samples - Main themes

Theme 1	Audible speaking Sample	8a	8b	8c	8k	8i			
Theme 2	Emotions/feelings	8c	8d	8f	8i	8k			
Theme 3	Plans	8m	8n	8o	8p	8q	8r	8s	8s
Theme 4	About me	8u	8v	8w	8x				

Theme 5	Developing language	8y	8z						

Appendix XXVI. Table 9.1.Outcomes of Phases

STUDY ONE	Praat Praat was identified and used as an appropriate tool for the acoustic phonetic analysis of SV utterances. Pratt enabled the comparison of samples of the researcher's whispered and spoken words with the participant's SV utterance. Praat produced ectrograms that showed the different acoustic and speech features of the utterances	Spectrograms Spectrograms identified similarities and differences in samples of the researcher's whisper and spoken speech and the participant's SV utterance. Spectrograms visually represented the features of SV utterances, facilitating the analysis of vowels.	Waveforms Formants Waveforms on Praat spectrograms displayed the presence of vowels. The presence of formants identified the relationship of mouth shape to vowel sounds in samples of both participant and researcher samples	Acoustic Energy and oral shape Praat identified acoustic energy in the same frequencies in researcher whispered and spoken words and participant SV utterances Participants were shown to be are approximating mouth shapes to produce vowels albeit atypically	Normal Speech Analysis demonstrated that SV utterances contained features of normal speech and whisper, contributing to a 'speech like' event. Pratt samples could not identify how the participant achieved the oral tract shapes approximating normative vowels	Articulatory targets Spectrograms provided evidence of the failure of participants to meet articulatory targets in comparison with spoken and whispered researcher samples
STUDY TWO	Intelligibility SV utterances were intelligible in open and closed conditions. Utterances were most intelligible in closed conditions. There was no statistically significant difference between listener intelligibility for familiar or naïve listeners.	Test results Test results showed a strong trend towards correct responses for Tests 2,3,5 and 7. (Mean 85% and above) Results for Tests 1 and 4 show lesser scores (Mean 61% and 67%) Most test items in closed tests were perceived correctly by most listeners	Best conditions In closed conditions CVC words (consonant, vowel, consonant) were most intelligible to listeners The relationship of semantic context to intelligibility was positive.	Listener conditions Overall Percentage intelligibility was 81.5% in closed conditions and 46.9% in open conditions. Listeners found contiguous utterances in open tests to be the most challenging Results in open tests suggested a negative association between intelligibility and utterance length.	Listener Results Listeners correctly identified 1,370 words out of 1,680 in 7 closed tests. Listeners correctly identified 1,422 words out of 3,080 in 3 open tests.	All results Combined results for open and closed tests showed listeners perceived 2,817 words out of 4,760. The range for all listener scores was 27.8%

STUDY THREE	P Levels All participants attained P levels in excess of those attributed to them prior to recording utterances. All participants met descriptors and criteria for language at P6 as the minimum and P8 at the maximum. All participants were beyond stages associated with infancy	Milestones 13 participants achieved milestones at 5 years plus. participants achieved milestones at 4-5 years. participants achieved milestones at 3-4 years	MLU 14 participants reached an Age Equivalent MLU score between:6 - 8+ years 6 participants achieved Age Equivalent MLU scores between:4 -5 years.	Rules/Procedures All participants adhered to the rules and procedures necessary for Turn Taking During turn taking exchanges, all participants maintained joint focus of interest.	Intonation Participants used intonation in inaudible SV utterances. Participants demonstrated appropriate intonation to signal emotional states	Assessment The content of utterances could be used to establish developmental and linguistic levels. Participants demonstrated the spontaneous acquisition of facts and knowledge

STUDY FOUR	Meaningful language Participants could respond meaningfully to express their own views and opinions about their SV utterances	Developing language Participants could not describe where or how they had developed their SV language. Participants were aware that their SV utterances had existed unrecognised, prior to the research.	Amplified SV Participants had not anticipated that their sub vocal utterances could be amplified and heard by themselves and others.	Talking and Speaking Participants recognised their amplified SV utterances as ‘talking’ or ‘speaking’ and that they were using language made up of words.	Self advocacy Participants could express choices and preferences. Participants could plan and advocate for themselves.	Self esteem Participants did not recognise in themselves the intellectual limitations ascribed to them.